



CARLSON ENVIRONMENTAL, INC.

Sent by Messenger

March 16, 1999

PN 9566C

Mr. John J. O'Grady
Remedial Project Manager
US EPA Region V
Superfund Division
Remedial Response Branch
77 West Jackson
Chicago, Illinois 60604

RE: Quality Assurance Project Plan
Fansteel, Inc.
North Chicago, Illinois

Dear Mr. O'Grady:

The enclosed *Quality Assurance Project Plan* prepared by Carlson Environmental, Inc. (CEI) has been revised to incorporate the format and information specified in *Region 5 Superfund Model Quality Assurance Project Plan, Revision 1, May 1996*.

Information intended to supplement Great Lakes Analytical's *Quality Assurance Program* is being submitted simultaneously, under separate cover.

Please feel free to contact Margaret Karolyi of CEI at (312) 704-8843 if you need any additional information.

Respectfully submitted,

CARLSON ENVIRONMENTAL, INC.

Margaret M. Karolyi, P.E.
Project Manager

EPA Region 5 Records Ctr.



229897

enclosure

cc: Kevin Keeley, Great Lakes Analytical
Clifton A. Lake, McBride Baker & Coles
Jonathan E. Jackson, Fansteel, Inc.



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QUALITY ASSURANCE PROJECT PLAN

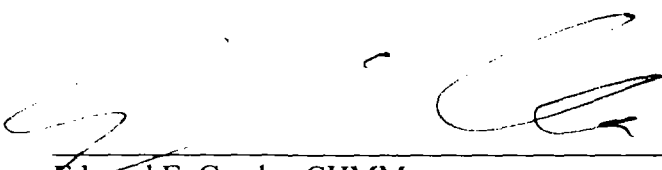
for the Site Investigation at:

Fansteel, Inc.
Number One Tantalum Place
North Chicago, Illinois

Prepared by
CARLSON ENVIRONMENTAL, INC.

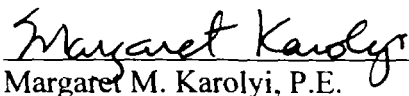
Project No. 9566C

Revised Version 1
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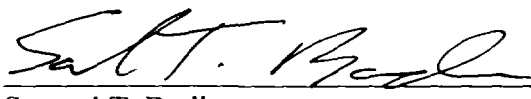
Edward E. Garske, CHMM
Carlson Environmental, Inc. Project Director

3/16/99
Date



Margaret M. Karolyi, P.E.
Carlson Environmental, Inc. Project Manager

3/16/99
Date



Samuel T. Bodine
Carlson Environmental, Inc. QA Manager

3/16/99
Date



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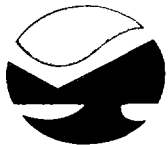
FIGURES

FIGURE 1.1	The Data Quality Objectives Process
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TABLES

(Reprinted from *Site Investigation Work Plan*)

TABLE ONE	Site Investigation Sampling Summary
TABLE THREE	Soil and Sediment Action Levels - TAL Metals/Ta/CN (<i>revised</i>)
TABLE EIGHT	Site Investigation - Estimated Schedule of Tasks



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LIST OF ACRONYMS

CEI - Carlson Environmental, Inc.
CN - cyanide
DQO - Data Quality Objective
EE/CA - Engineering Evaluation and Cost Assessment
EJ&E - Elgin, Joliet & Eastern (EJ&E) Railroad
EPA - United States Environmental Protection Agency (EPA)
GC/MS - gas chromatograph/mass spectrometer
GLA - Great Lakes Analytical
HASP - Site Health and Safety Plan
HSO - Health & Safety Officer
HWMU - Hazardous Waste Management Unit
IEPA - Illinois Environmental Protection Agency
MS - matrix spikes
MS/MSD - matrix spike/matrix spike duplicate
NIST - National Institute of Standard Technology
OVA - organic vapor analyzer
PCBs - polychlorinated biphenyls
PID - photoionization detector
QA - quality assurance
QAPP - Quality Assurance Project Plan
QC - quality control
RCRA - Resource Conservation and Recovery Act
RPM - Remedial Project Manager



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LIST OF ACRONYMS (Continued)

RPD - relative percent difference
RSD - relative standard deviations
SOPs - Standard Operating Procedures
SRM - standard reference materials
Ta - tantalum, a specialty metal used by Fansteel
TAL - Target Analyte List
TCE - trichloroethene
VOA - volatile organic analysis (VOA) trip blank
VOCs - volatile organic compounds

LIST OF PERSONS WHO HAVE RECEIVED THIS QAPP

Carlson Environmental, Inc. - Ms. Margaret M. Karolyi

Fansteel, Inc. - Mr. Jonathan E. Jackson

McBride Baker & Coles - Mr. Clifton A. Lake

EPA Region V - Mr. John J. O'Grady

Great Lakes Analytical - Mr. Kevin Keeley



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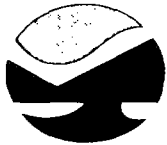
1.0 PROJECT DESCRIPTION

1.1 Introduction - The purpose of the proposed Site Investigation is to conduct an investigation that complies with a request from the United States Environmental Protection Agency (EPA) to conduct an investigation to identify any potential contaminant plumes which may be impacting the contamination detected at the adjacent Vacant Lot Site, and to collect additional samples from Pettibone Creek, which flows across the Vacant Lot Site in a north to south direction.

During the Site Investigation, data collection will be conducted in phases and compared to the action levels established in the *Site Investigation Work Plan*. If contaminant concentrations are detected above the action levels, Fansteel may propose alternative site-specific remediation objectives using a risk-based type of analysis (i.e. a Tier 2 or Tier 3 analysis). If soil contamination or a ground water contaminant plume that appears to be impacting the Vacant Lot Site and/or Pettibone Creek is detected above these site-specific remediation objectives, an additional investigation will be performed to delineate the extent of contamination and to investigate possible off-site sources of contamination. The results of the investigation(s) will be detailed in a *Site Investigation Report*.

Upon completion of the proposed investigation(s) and evaluation of the results, Fansteel will identify potential off-site sources of contamination and define the extent of contaminant plumes that may be impacting the Vacant Lot Site. If the investigation results indicate that contamination at the Fansteel North Chicago facility is significantly impacting the adjacent Vacant Lot Site and remediation at the Fansteel North Chicago facility is appropriate, Fansteel will research viable remediation alternatives and prepare an *Engineering Evaluation and Cost Assessment (EE/CA) Report*, if necessary.

This *QAPP* has been prepared by Carlson Environmental, Inc. (CEI) on behalf of Fansteel, Inc. and is being submitted for EPA review. Previously, a *Site Investigation Work Plan* dated April 1998 was prepared by CEI and submitted for EPA review. Included as Attachments to



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the *Work Plan* were a *Quality Assurance Project Plan (QAPP)*, a *Site Health and Safety Plan (HASP)* and a *Quality Assurance Program* prepared by Great Lakes Analytical (GLA). The EPA reviewed the *Work Plan* and attached documents and issued a comment letter dated June 20, 1998. A revised *Site Investigation Work Plan* and *HASP* (both dated October 1998) have been submitted as separate documents for EPA review. This *QAPP* (version 1.0) is being submitted for EPA review and approval. A letter from GLA with laboratory Standard Operating Procedures (SOPs) have been submitted as a separate document, simultaneously with CEI's *QAPP*. The GLA letter and attached SOPs address the comments in the EPA June 20, 1998 letter that pertain to the laboratory quality assurance issues.

1.2 Site Description - A site description is provided in Section 2.0 of the *Site Investigation Work Plan*, which is herein incorporated into this *QAPP* through reference, including the drawings which have been submitted along with the *Site Investigation Work Plan*.

1.2.1 Facility/Site Size and Borders - The Fansteel North Chicago facility is located at Number One Tantalum Place, approximately two miles east of the intersection of Martin Luther King Jr. Street and U.S. Highway 41, in North Chicago, Lake County, Illinois (refer to Figure One in Attachment A of the *Site Investigation Work Plan*). The site is bounded by the North Chicago Refiners and Smelters facility to the east, Martin Luther King Jr. Street and the Federal Chicago plant to the south, the Vacant Lot Site to the west, and the Elgin, Joliet & Eastern (EJ&E) Railroad to the north.

The site consists of an older plant complex located on an approximately eight-acre parcel. There are two brick buildings on the site; the boiler house and the main production building which is comprised of multi-story and multi-use inner buildings. In addition, a transite building and a few aluminum buildings are present on the site. Total gross floor space is reportedly 325,500 square feet.



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The portions of the property not covered by buildings are generally asphalt- or concrete-paved and are used as parking lot areas or access ways. Two large, empty upright above-ground tanks are located at the northern end of the property. A railroad spur is located just inside the eastern edge of the site, and an elevated railroad siding is located just south of the above-ground tanks. The entire site is enclosed by security fencing, and there is some vegetation, consisting of grass and bushes, between the office area and Martin Luther King Jr. Street. Refer to Figure Two in Attachment A of the *Site Investigation Work Plan*.

1.2.2 Topography -The site topography is essentially flat, although on the east side, the site is elevated near the fence line, sloping down into the parking lot. The building is elevated compared to the parking lot, and the railroad spur on the east side is several feet below the site grade. The railroad property north of the site slopes steeply downwards toward the site.

1.2.3 Site Physiography - Refer to Section 2.2 of the *Site Investigation Work Plan* for information concerning the site geology and soil. Information regarding Pettibone Creek is included in Section 2.5 of the *Site Investigation Work Plan*.

1.3 Past Data Collection Activities - The previous sampling events at the Fansteel North Chicago facility and the Vacant Lot Site/Pettibone Creek are discussed in Sections 1.1.1 and 1.1.2 of the *Site Investigation Work Plan*, respectively. Fansteel is currently undergoing a RCRA Closure of a former Hazardous Waste Management Unit (HWMU). The most recent investigative work involved soil sampling conducted by CEI in 1990. During the RCRA-related investigations, elevated concentrations of trichloroethene (TCE), lead and cadmium were detected in the site soils.

1.4 Current Status - The site is currently used by Fansteel as office space for its corporate headquarters. Production related activities ceased at the North Chicago facility in 1990. The former plant buildings are primarily vacant and are routinely maintained, as necessary.



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The investigation results from CEI's 1990 soil sampling were submitted by Fansteel to the Illinois Environmental Protection Agency (IEPA) RCRA Section. Fansteel intends to work with the IEPA RCRA Section to complete the RCRA Closure of the HWMU. At this time, Fansteel is waiting for a response from the IEPA regarding the most recent submittal.

In the letter to The Fansteel Corporation dated June 17, 1997, the EPA has requested that Fansteel conduct an investigation of the Fansteel North Chicago facility to identify any potential contaminant plume which may be contributing to the contamination detected at the Vacant Lot Site, and to collect additional samples from Pettibone Creek. Upon receiving approval of the *Site Investigation Work Plan*, *HASP* and *QAPP*, Fansteel plans to proceed with the Site Investigation according to the project schedule included in Section 6.3 of the *Site Investigation Work Plan*.

1.5 Project Objectives

1.5.1 Specific Objectives and Associated Tasks - The activities detailed in the *Site Investigation Work Plan* are intended to comply with the request from the EPA to conduct an investigation, as outlined in a letter to The Fansteel Corporation dated June 17, 1997.

As outlined in the EPA's letter, the proposed Site Investigation is to accomplish the following two goals:

- Identify the nature and extent of potential contamination on the Fansteel facility, including any potential contamination that may be contributing to the ground water contamination previously identified at the adjacent Vacant Lot Site (especially potential sources of trichloroethene); and
- Conduct additional sampling of the sediments of Pettibone Creek to determine the nature and extent of the sediment contamination.



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The proposed Site Investigation includes the emplacement of 33 soil borings and the installation of 9 ground water monitoring wells on or along the Fansteel property. The borings and monitoring wells will be sampled for volatile organic compounds (VOCs) and selected metals. Additionally, twelve sediment samples will be collected from Pettibone Creek and the associate banks, and sampled for selected metals, cyanide and polychlorinated biphenyls (PCBs). The metals analyses will include analysis for the presence of tantalum (Ta), a specialty metal used by Fansteel. Table One in Appendix B of this *QAPP* was reprinted from Attachment B of the *Site Investigation Work Plan* and lists the number of samples from each media that will be submitted for laboratory analysis of the project-specific analytes.

1.5.2 Project Target Parameters and Intended Data Usages - The media to be investigated and the contaminants of concern are outlined in Section 3.0 of the *Site Investigation Work Plan*. The sampling results from the Site Investigation will be compared to the action levels detailed in Tables Two through Seven in Attachment B of the *Site Investigation Work Plan*. If contaminant concentrations are detected above these action levels, Fansteel may propose alternative site-specific remediation objectives using a risk-based type of analysis (i.e. a Tier 2 or Tier 3 analysis). If soil contamination or a ground water contaminant plume that appears to be impacting the Vacant Lot Site and/or Pettibone Creek is detected above these site-specific remediation objectives, an additional investigation will be performed to delineate the extent of the contaminant and to investigate possible off-site sources of contamination. The results of the investigation(s) will be detailed in a *Site Investigation Report*.

Upon completion of the proposed investigation(s) and evaluation of the results, Fansteel will identify potential off-site sources of contamination and define the extent of contaminant plumes that may be impacting the Vacant Lot Site. If the investigation results indicate that contamination at the Fansteel North Chicago facility is significantly impacting the adjacent Vacant Lot Site and remediation at the Fansteel North Chicago facility is appropriate, Fansteel will research viable remediation alternatives and prepare an *Engineering Evaluation and Cost Assessment (EE/CA) Report*, if necessary.



1.5.3 Quality Objectives and Criteria for Measurement Data - The Data Quality Objective (DQO) Process is a series of planning steps based on the Scientific Method that is designed to ensure that the type, quality, and quantity of environmental data used in decision making are appropriate for intended application. The steps of DQO Process are included in Figure 1.1 in Appendix A.

DQO are qualitative and quantitative statements derived from outputs of each step of the DQO Process that:

- Clarify the study objective;
- Define the most appropriate type of data to collect;
- Determine the most appropriate conditions from which to collect the data; and

The DQO are then used to develop a scientific and resource-effective sampling design.

The DQO Process allows decision makers to define their data requirements and acceptable levels of decision during planning before any data are collected. DQO should be based on the seven step process outlined in Figure 1.1 in Appendix A.

1.6 Sample Network Design and Rationale - The sampling locations are shown in Figures Two and Three in Attachment A of the *Site Investigation Work Plan*. The rationale for the sampling locations is described in Section 4.2 of the *Site Investigation Work Plan*. CEI notes that additional samples may be collected and/or analyzed as necessary to meet the project objectives.

1.6.1 Sample Network by Task and Matrix - Sample matrices, analytical parameters and frequencies of sample collection are listed in Table One in Appendix B.



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1.6.2 Site Maps of Sample Locations - Maps showing the planned soil, ground water and sediment sampling locations are included as Figures Two and Three in Attachment A of the *Site Investigation Work Plan*.

1.6.3 Rationale of Selected Sampling Locations - The rationale for the sampling locations is described in Section 4.2 of the *Site Investigation Work Plan*. CEI notes that additional samples may be collected and/or analyzed as necessary in order to delineate the extent of contamination on the Fansteel property that may be contributing to the contamination detected on the adjacent Vacant Lot Site.

1.7 Project Schedule - The project schedule is outlined in Table Eight in the *Site Investigation Work Plan*. A reprint of this table is included in Appendix B of this *QAPP*.

1.7.1 Anticipated Date of Project Mobilization - Mobilization will occur within three weeks of receiving EPA approval of this *QAPP*.

1.7.2 Task Bar Chart and Associated Time Frames - Table Eight in Appendix B outlines the time frames associated with each project task. It is estimated that the activities related to the completion of the Site Investigation (including field work, possible subsequent investigations to define the extent of contamination, and report preparation) will take approximately 48 weeks to complete.



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2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

2.1 Project Organization Chart - A project organization chart is included as Figure 2.1 in Appendix A of this *QAPP*. CEI is conducting the investigation on behalf of Fansteel, Inc., rather than as a contractor to the EPA. However, as shown in the project organization chart, CEI will correspond with Mr. John J. O'Grady, Remedial Project Manager for the Region V EPA, Superfund Division.

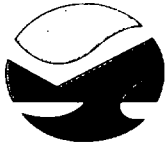
2.2 Management Responsibilities - CEI's project management team involved in developing the *Site Investigation Work Plan* and conducting investigations at the facility includes the following individuals:

- Project Director Edward E. Garske, CHMM
- Project Manager Margaret M. Karolyi, P.E.
- Project Engineer Kenneth W. James, P.E.

Project Director - will have final responsibility and authority for all work performed. Mr. Garske will assure the resources required to successfully complete the project are committed.

Project Manager - is the key manager of project activities and is responsible for:

- Managing project operations and activities.
- Conducting technical review of each task being performed.
- Maintaining clear and effective communication with Fansteel's Project Manager.
- Working with Fansteel in project scoping and planning.
- Ensuring appropriate technical resources are utilized for each task.



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- Ensuring field activities are conducted in accordance with program Health and Safety and QA/QC requirements.
- Ensuring proper technical consultation is provided.
- Maintaining overall project technical continuity.
- Controlling costs and schedule aspects of all project activities.

Project Engineer - will be responsible for maintaining the quality of all engineering activities associated with the project in addition to establishing detailed task specifications including schedules and estimates of labor and material costs.

As indicated in the *HASP*, Lisa Meagher of CEI is designated as the Health & Safety Officer (HSO). Since only two to three CEI project personnel will be on site at any given time, for purposes of this project, the HSO will also function as the Site Supervisor. Margaret Karolyi and Bruce Shabino are assigned as designated alternates for the HSO/Site Supervisor position.

2.3 Quality Assurance Responsibilities

QA Manager

Samuel Bodine is designated as CEI's QA Manager. The QA manager will remain independent of direct job involvement and the day-to-day operations associated with this project, and have direct access to corporate executive staff as necessary, to resolve any QA dispute. Specific functions and duties include:

- Providing QA audit on various phases of the field operations;
- Reviewing and approving of QA plans and procedures;
- Providing QA technical assistance to project staff;
- Review the sample results from the analytical laboratory for data validation purposes;



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- Reporting on the adequacy, status, and effectiveness of the QA program on a regular basis to the Project Manager and the Project Director.

2.4 Field Responsibilities

CEI Site Supervisor - CEI's Project Manager will be supported by the Site Supervisor (who will function as the field team leader). The Site Supervisor is responsible for leading and coordinating the day-to-day activities of the various workers and contractors under his/her supervision. Specific field team leader responsibilities include:

- Provision of day-to-day coordination with the project manager and project engineer on technical issues in specific areas of expertise;
- Developing and implementing of field-related work plans, assurance of schedule compliance, and adherence to management-developed study requirements;
- Coordinating and managing of field staff including sampling, drilling, and supervising field laboratory staff;
- Acting as field sample custodian;
- Implementing of QC for technical data provided by the field staff including field measurement data;
- Authoring, writing, and approving of text and graphics required for field team efforts;
- Coordinating and overseeing of technical efforts of subcontractors assisting the field team;
- Identifying problems at the field team level, resolving difficulties in consultation with the project manager, implementing and documenting corrective action procedures, and provision of communication between team and upper management; and
- Participating in preparation of the final report.



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CEI Field Technical Staff - The technical staff (team members) for this project will be drawn from CEI's pool of corporate resources. The technical team staff will be utilized to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

2.5 Laboratory Responsibilities - The laboratory specified for this project, Great Lakes Analytical (GLA), of Buffalo Grove, Illinois, will complete the analytical testing for this project in accordance with the policies and procedures outlined in its *Quality Assurance Program* and laboratory SOPs.

GLA Project Manager - Deborah Lowe, GLA Laboratory Manager, will function as the Project Manager. She will report directly to the CEI Project Manager and will be responsible for the following:

- Ensuring all resources of the laboratory are available on an as-required basis; and
- Overseeing of final analytical reports.

GLA Operations Manager - The GLA Project Manager will appoint an Operations Manager who will have the responsibilities listed below.

- Coordinating laboratory analyses;
- Supervising in-house chain-of-custody;
- Scheduling sample analyses;
- Overseeing data review;
- Overseeing preparation of analytical reports; and
- Approving final analytical reports prior to submission to CEI.



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GLA Quality Assurance Officer - Ronald Osborn will function as the GLA QA Officer and has the overall responsibility for data after it leaves the laboratory. The GLA QA Officer will be independent of the laboratory but will communicate data issues through the GLA Project Manager. In addition, the GLA QA Officer will:

- Overview laboratory quality assurance;
- Overview QA/AC documentation;
- Conduct detailed data review;
- Determine whether to implement laboratory corrective actions, if required;
- Define appropriate laboratory QA procedures; and
- Prepare laboratory Standard Operating Procedures.

GLA Sample Custodian - The GLA sample custodian will report to the GLA Operations Manager. Responsibilities of the GLA Sample Custodian will include:

- Receiving and inspecting the incoming sample containers;
- Recording the condition of the incoming sample containers;
- Signing appropriate documents;
- Verifying chain-of-custody and its correctness;
- Notifying Laboratory Manager and Laboratory Supervisor of sample receipt and inspection;
- Assigning a unique identification number and customer number, and entering each into the sample receiving log;
- With the help of the laboratory manager, initiating transfer of the samples to appropriate lab sections; and
- Controlling and omitting access/storage of samples and extracts.

Final responsibility for project quality rests with CEI's Project Manager. Independent quality assurance will be provided by the GLA Project Manager and QA Officer prior to release of all data to CEI.



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GLA Technical Staff - The GLA technical staff will be responsible for sample analysis and identification of corrective actions. The staff will report directly to the GLA Operations Manager.



3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT

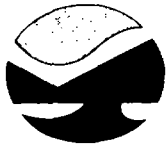
The overall QA objective for this project is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide results which are legally defensible in a court of law. Specific procedures for sampling, chain-of-custody, laboratory instrument calibration, laboratory analysis, reporting of data, internal quality control, audits, preventive maintenance of field equipment, and corrective action are described in other sections of this *QAPP* and GLA's *Quality Assurance Program*, as referenced.

3.1 Precision

3.1.1 Definition - Precision is a measure of the degree to which two or more measurements are in agreement.

3.1.2 Field Precision Objectives - Field precision is assessed through the collection and measurement of field duplicates at a rate of 1 duplicate per 10 analytical samples. The total number of duplicates planned for this project are found in Table One in Appendix B.

3.1.3 Laboratory Precision Objectives - Precision in the laboratory is assessed through the calculation of relative percent differences (RPD) and relative standard deviations (RSD) for three or more replicate samples. The equations to be used for precision in this project can be found in Section 8.3 of the GLA *Quality Assurance Program*. Precision control limits are discussed in Section 9.6 of the GLA *Quality Assurance Program* and are provided in the GLA SOPs.



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3.2 Accuracy

3.2.1 Definition - Accuracy is the degree of agreement between an observed value and an accepted reference value.

3.2.2 Field Accuracy Objectives - Accuracy in the field is assessed through the use of field and trip blanks and through the adherence to all sample handling, preservation and holding times. Field personnel will follow the CEI SOPs included as Appendix C to this *QAPP*.

3.2.3 Laboratory Accuracy Objectives - Laboratory accuracy is assessed through the analysis of matrix spikes (MS) or standard reference materials (SRM) and the determination of percent recoveries. The equation to be used for accuracy in this project can be found in Section 8.6.2 of the GLA *Quality Assurance Program*. Accuracy control limits are discussed in Section 8.6.5.1 of the GLA *Quality Assurance Program* and the GLA SOPs.

3.3 Completeness

3.3.1 Definition - Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions.

3.3.2 Field Completeness Objectives - Field completeness is a measure of the amount of valid measurements obtained from all the measurements taken in the project. The equation for completeness is presented in Section 12 of this *QAPP*. Field completeness for this project will be greater than 90%.

3.3.3 Laboratory Completeness Objectives - Laboratory completeness is a measure of the amount of valid measurements obtained from all the measurements taken in the project.



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The equation for completeness is presented in Section 12 of this *QAPP*. Laboratory completeness for this project will be greater than 90 percent.

3.4 Representativeness

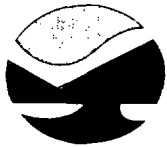
3.4.1 Definition - Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

3.4.2 Measures to Ensure Representativeness of Field Data - Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that proper sampling techniques, in accordance with Section 4 of this *QAPP* and CEI's SOPs are used. CEI's SOPs are included in Appendix C.

3.4.3 Measures to Ensure Representativeness of Lab Data - Representativeness in the laboratory is ensured by using the proper analytical procedures, meeting sample holding times and analyzing and assessing field duplicate samples. The sampling network is designed to provide data representative of facility conditions. During development of this network, consideration is given to past site usage, existing analytical data, physical setting and processes, and constraints inherent to the Superfund Program. The rationale of the sampling network is discussed in Section 1.6.3.

3.5 Comparability

3.5.1 Definition - Comparability is an expression of the confidence with which one data set can be compared with another. Comparability is also dependent on similar QA objectives.



3.5.2 Measures to Ensure Comparability of Field Data - Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the *Site Investigation Work Plan* is followed and that proper sampling techniques consistent with CEI's SOPs are used.

3.5.3 Measures to Ensure Comparability of Lab Data - Planned analytical data will be comparable when similar sampling and analytical methods are used and documented in the *QAPP*. Comparability is also dependent on similar QA objectives.

3.6 Level of Quality Control Effort

Field blank, trip blank, method blank, duplicate, standard reference materials (SRM) and matrix spike samples will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs.

Field and trip blanks consisting of distilled water, will be submitted to the analytical laboratories to provide the means to assess the quality of the data resulting from the field sampling program. Field blank samples are analyzed to check for procedural contamination at the facility which may cause sample contamination. Trip blanks are used to assess the potential for contamination of samples due to contaminant migration during sample shipment and storage. Trip blanks generally pertain to volatile organic samples only. Trip blanks will be prepared prior to the sampling event in the actual sample containers and are kept with the investigative samples throughout the sampling event. They are then packaged for shipment with other samples and sent for analysis. There should be one trip blank included in each sample shipping container. At no time after their preparation are the sample containers to be opened before they reach the laboratory.

Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory procedures. Duplicate samples are analyzed to check for sampling



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and analytical reproducibility. Matrix spikes provide information about the effect of the sample matrix on the digestion and measurement methodology. All matrix spikes are performed in duplicate and are hereinafter referred to as MS/MSD samples. One matrix spike/matrix spike duplicate will be collected for every 20 investigative samples. MS/MSD samples are designated/ collected for organic analyses only.

MS/MSD samples are investigative samples. Soil MS/MSD samples require no extra volume for VOCs or extractable organic. However, aqueous MS/MSD samples must be collected at triple the volume for VOCs and double the volume for extractable organics. One MS/MSD sample will be collected/designated for every 20 investigative samples per sample matrix (i.e., ground water, soil).

The general level of the QC effort will be one field duplicate for every 10 investigative samples. One field blank will be collected each day field sampling is conducted. One volatile organic analysis (VOA) trip blank consisting of distilled deionized ultra pure water will be included along with each shipment of aqueous VOA samples.

The number of duplicate and field blank samples to be collected are listed in Table One in Appendix B.



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4.0 SAMPLING PROCEDURES

The proposed Site Investigation includes soil, sediment and ground water sampling. A site-specific sampling plan is outlined in Section 4.0 of the *Site Investigation Work Plan*. Additional information regarding CEI's general sampling procedures is included in CEI's SOPs, included as Appendix C to this *QAPP*.



5.0 CUSTODY PROCEDURES

Custody is one of several factors which is necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection; laboratory analysis; and final evidence files. Final evidence files, including all originals of laboratory reports and purge files, are maintained under document control in a secure area.

A sample or evidence file is under your custody if:

- the item is in actual possession of a person; or
- the item is in the view of the person after being in actual possession of the person; or
- the item was in actual physical possession but is locked up to prevent tampering; or
- the item is in a designated and identified secure area.

5.1 Field Custody Procedures

Field logbooks or borehole logs will provide the means of recording data collecting activities performed. As such, entries will be described in as much detail as possible so that persons going to the facility could reconstruct a particular situation without reliance on memory.

Field logbooks or borehole logs will be bound, field survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in the document control center when not in use. Each logbook will be identified by the project-specific document number.

The title page of each logbook will contain the following:



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- Person to whom the logbook is assigned.
- Logbook number.
- Project Name.
- Project start date, and
- Project end date.

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered. The names of visitors to the site, field sampling or investigation team personnel and the purpose of their visit will also be recorded in the field logbook.

Measurements made and samples collected will be recorded. All entries will be made in ink, signed, and dated and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark which is signed and dated by the sampler. Whenever a sample is collected, or a measurement is made, a detailed description of the location of the station, shall be recorded. The number of the photographs taken of the station, if any, will also be noted. All equipment used to make measurements will be identified, along with the date of calibration (unless the calibration is recorded in a separate log book dedicated to the instrument).

Samples will be collected following the sampling procedures referenced in Section 4.0 of this *QAPP*. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume and number of containers will be recorded on boring logs and/or the field logbook. Sample site-specific identification numbers will be assigned prior to sample collection.



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The site-specific sample number should consist of the following for soil, sediment and ground water samples:

- An alphanumeric designation indicating the sample location (i.e., SB-1 for soil boring number 1, MW-2 for monitoring well number 2, SED-1 for sediment sample location number 1, etc.);
- A letter designation corresponding to the sample depth. This letter designation would only apply to soil and sediment samples for this project (i.e., SB-1A for the shallowest soil sample collected from soil boring 1);
- The suffix -DUP for field duplicate samples (i.e., SB-14A-DUP).

The site-specific sample number should consist of the following for field blank and trip blank samples:

- A letter designation as to the type of blank sample (i.e., FB- for field blank and TB- for trip blank);
- A numerical designation indicating the Julian day and year (i.e., FB-001-99 for the field blank collected on January 1, 1999).

5.2 Laboratory Custody Procedures - The laboratory custody procedures for sample receiving and log-in; sample storage and numbering; tracking during sample preparation and analysis; and storage of data are described in Section 6 of the GLA *Quality Assurance Program*.

5.3 Final Evidence Files - The final evidence file will be the central repository for all documents which constitute evidence relevant to sampling and analysis activities as described in this *QAPP*. CEI is the custodian of the evidence file and maintains the contents of evidence files for the site, including all relevant records, reports, logs, field logbooks,



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pictures, subcontractor reports and data reviews in a secured limited access area within CEI's corporate headquarters.

The final evidence file will include at a minimum:

- field logbooks
- field data and data deliverables
- photographs
- drawings
- soil boring logs
- laboratory data deliverables
- data validation reports
- data assessment reports
- progress reports, QA reports, interim project reports, etc.
- all custody documentation (tags, forms, air bills, etc.).



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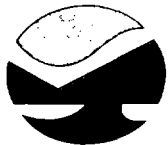
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6.0 CALIBRATION PROCEDURES AND FREQUENCY

This section describes the calibration procedures and the frequency at which these procedures will be performed for both field and laboratory instruments.

6.1 Field Instrument Calibration - The field instruments will be calibrated in accordance with CEI's corporate program for instrument inspection, maintenance, and repair. Employees working on this project will be trained to properly calibrate and use field instruments such as the photoionization detector (PID), organic vapor analyzer (OVA), and YSI meter (for pH, temperature and conductivity readings).

6.2 Laboratory Instrument Calibration - GLA is responsible for the laboratory instrument calibration. The calibration procedures are described in Section 8 of the GLA *Quality Assurance Program* and the corresponding laboratory SOPs.



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7.0 ANALYTICAL PROCEDURES

Soil, sediment and ground water samples collected during the Site Investigation will be analyzed by:

Great Lakes Analytical
1380 Busch Parkway
Buffalo Grove, Illinois 60089
(847) 808-7766

7.1 Field Analytical Procedures - The standardization and QA information for field measurements of pH, specific conductivity, and temperature are described in Section 3.0 of this *QAPP* and the SOPs included as Appendix C.

7.2 Laboratory Analytical & Measurement Procedures - The laboratory listed above will implement the project required SOPs. These laboratory SOPs for sample preparation, cleanup and analysis are based on SW-846. These SOPs provide sufficient details and are specific to this investigation. These SOPs were forwarded simultaneously with this *QAPP* for EPA, review under separate cover, as an attachment to GLA's letter responding to the EPA's July 20, 1998, letter.

7.2.1 List of Project Target Compounds & Detection Limits - A complete listing of project target compounds, project quantitation limits, and current laboratory detection limits for each analyte group can be found in Tables Two through Seven in Attachment B of the *Site Investigation Work Plan*.

At the time these tables were prepared, a detection limit study for the analysis of tantalum (Ta), a project-specific compound, were being completed by GLA. Table Three in Appendix B of this *QAPP* is a revised copy of Table Three in the *Site Investigation Work Plan* and includes the laboratory limits for Ta.



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7.2.2 List of Associated QC Samples - Section 8.6.5 of the GLA *Quality Assurance Program* and the corresponding laboratory SOPs address the minimum QC requirements for the analysis of specific analyte groups.



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8.0 INTERNAL QUALITY CONTROL CHECKS

8.1 Field Quality Control Checks - QC procedures for pH, specific conductance and temperature of water samples will include calibrating the instruments as described in Section 6.0 of the *QAPP*, measuring duplicate samples and checking the reproducibility of the referenced standard. The QC information of the field equipment is stated in Section 3.0 of this *QAPP*. The thermometer used will be compared to a NIST traceable thermometer (or equivalent). Soil color checks during the soil boring activities will be performed using Munsell color charts. Assessment of field sampling precision and bias will be made by collecting field duplicates and field blanks for laboratory analysis. Collection of the samples will be in accordance with CEI's SOPs and at the frequency indicated in Table One in Appendix B.

8.2 Laboratory QC Checks - Internal quality control checks and internal audit procedures are described in Sections 10 and 11, respectively, of the GLA *Quality Assurance Program* and the corresponding laboratory SOPs.



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9.0 DATA REDUCTION, VALIDATION AND REPORTING

All data generated through the field activities, or by the laboratory operation shall be reduced, and validated prior to reporting. No data shall be disseminated by the laboratory until it has been subjected to these procedures which are summarized in subsections below:

9.1 Data Reduction

9.1.1 Field Data Reduction Procedures - Field data reduction procedures will be minimal in scope compared to those implemented in the laboratory setting. Only direct read instrumentation will be employed in the field. The use of pH meters, thermometers, an OVA or PID, and a meter to measure specific conductance will generate some measurements directly read from the meters following calibration per manufacturer's recommendations as outlined in Section 6 of this *QAPP*. Such data will be written into the boring logs and/or field logbooks immediately after measurements are taken.

If errors are made, results will be legibly crossed out, initialed and dated by the field member, and corrected in a space adjacent to the original (erroneous) entry. Later, when the results are subsequently compiled onto forms, tables and figures, the Site Supervisor, identified in Section 2 of this *QAPP*, will proof the forms to determine whether any transcription errors have been made by the field crew.

Because the use of field instrumentation such as a mobile gas chromatograph will not be used until a later phase of the study has been reached, there will be no further need for assuring that field data has been reduced properly through the use of formulas or interpretation of raw data printouts.

9.1.2 Laboratory Data Reduction Procedures - The laboratory data reduction procedures are presented in Section 12 of the GLA *Quality Assurance Program*.



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9.2 Data Validation - Data validation procedures shall be performed for both field and laboratory operations as described below.

9.2.1 Procedures Used to Validate Field Data - Procedures used to evaluate field data for this project primarily include checking for transcription errors and review of field logbooks, on the part of field crew members. This task will be the responsibility of the Site Supervisor. An additional review of the field data will be conducted by CEI's QA Manager, who did not participate in the collection of the actual field data.

9.2.2 Procedures Used to Validate Lab Data - CEI's QA Manager will review the laboratory deliverables to ensure that the sample chain-of-custody forms, analytical results, and QC summaries have been delivered. GLA will conduct the validation procedures outlined in Section 12 of the GLA *Quality Assurance Program* and in the corresponding laboratory SOPs.

9.3 Data Reporting - Data reporting procedures shall be carried out for field and laboratory operations as indicated below:

9.3.1 Field Data Reporting - Field data reporting shall be conducted principally through the transmission of report sheets containing tabulated results of all measurements made in the field, and documentation of all field calibration activities.

9.3.2 Laboratory Data Reporting - GLA will begin reporting the analytical laboratory results once the validation activities have been concluded. GLA's QA Manager will perform a final review of the report summaries and case narratives to determine whether the report meets project requirements. In addition to the record of chain-of-custody, the report format shall consist of the following:



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1. *Case Narrative:*

- Date of issuance
- Laboratory analysis performed
- Any deviations from intended analytical strategy
- Laboratory sample ID number
- Numbers of samples and respective matrices
- Quality control procedures utilized and also references to the acceptance criteria
- Laboratory report contents
- Project name and number
- Condition of samples "as-received"
- Discussion of whether or not sample holding times were met
- Discussion of technical problems or other observations which may have created analytical difficulties
- Discussion of any laboratory quality control checks which failed to meet project criteria
- Signature of the Laboratory QA Manager

2. *Chemistry Data Package*

- Case narrative for each analyzed batch of samples
- Summary page indicating dates of analyses for samples and laboratory quality control checks
- Cross referencing of laboratory sample to project sample identification numbers
- Data qualifiers to be used should be adequately described
- Sample preparation and analyses for samples
- Sample results



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- Raw data for sample results and laboratory quality control samples
- Results of (dated) initial and continuing calibration checks, and GC/MS tuning results
- Matrix spike and matrix spike duplicate recoveries, laboratory control samples, method blank results, calibration check compounds, and system performance check compound results
- Labeled (and dated) chromatogram/spectra of sample results and laboratory quality control checks
- Results of tentatively identified compounds



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10.0 PERFORMANCE AND SYSTEM AUDITS

10.1 Field Performance and System Audits - Performance and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the *Site Investigation Work Plan* and *QAPP*. The audits of field and laboratory activities include two independent parts: internal and external audits.

10.1.1 Internal Field Audits -

10.1.1.1 Internal Field Audit Responsibilities - Internal audits of field activities including sampling and field measurements will be conducted by the CEI QA Manager.

10.1.1.2 Internal Field Audit Frequency - These audits will verify that all established procedures are being followed. Internal field audits will be conducted at least once at the beginning of the site sample collection activities.

10.1.1.3 Internal Field Audit Procedures - The audits will include examination of field sampling records, field instrument operating records, sample collection, handling and packaging in compliance with the established procedures, maintenance of QA procedures, chain-of-custody, etc. Follow up audits will be conducted to correct deficiencies, and to verify that QA procedures are maintained throughout the remediation. The audits will involve review of field measurement records, instrumentation calibration records, and sample documentation. The field audit checklist to be used for this project is submitted with this *QAPP*.



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10.1.2 External Field Audits -

10.1.2.1 External Field Audit Responsibilities - External field audits may be conducted by the EPA Region 5.

10.1.2.2 External Field Audit Frequency - External field audits may be conducted any time during the field operations. These audits may or may not be announced and are at the discretion of the EPA Region 5.

10.1.2.3 Overview of External Field Audit Process - External field audits will be conducted according to the field activity information presented in the *QAPP*.

10.2 Laboratory Performance and Systems Audits -

10.2.1 Internal Laboratory Audits - GLA performs internal audits, as outlined in Section 11 of the GLA *Quality Assurance Program*.

10.2.2 External Laboratory Audits -

10.2.2.1 External Lab Audit Responsibilities - An external audit may be conducted by EPA Region 5.

10.2.2.2 External Lab Audit Frequency - An external lab audit may be conducted at least once prior to the initiation of the sampling and analysis activities. These audits may or may not be announced and are at the discretion of the EPA.

10.2.2.3 Overview of External Lab Audit Process - External lab audits will include (but not be limited to) review of laboratory analytical procedures, laboratory on-site audits, and/or submission of performance evaluation samples to the laboratory for analysis.



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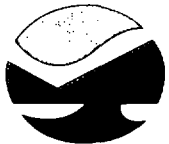
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11.0 PREVENTATIVE MAINTENANCE

11.1 Field Instrument Preventative Maintenance - The field equipment for this project includes thermometers, pH meter, and conductivity meter. Specific preventative maintenance procedures to be followed for field equipment are those recommended by the manufacturer. Field instruments will be checked and calibrated daily before use. Calibration checks will be documented in the field meter/ calibration log books. Backup instruments and equipment will be available on-site or within 1 day shipment to avoid delays in the field schedule. The maintenance schedule, equipment repairs, and ordering backup instruments will be coordinated by CEI's Field Equipment Manager.

11.2 Laboratory Instrument Preventative Maintenance -As part of their QA/QC Program, a routine preventative maintenance program is conducted by GLA to minimize the occurrence of instrument failure and other system malfunctions. GLA has an internal group to perform routine scheduled maintenance, and to repair or to coordinate with the vendor for the repair of all instruments. All laboratory instruments are maintained in accordance with manufacturer's specifications and the requirements of the specific method employed. This maintenance is carried out on a regular, scheduled basis, and is documented in the laboratory instrument service logbooks. Emergency repair or scheduled manufacture's maintenance is provided under a repair and maintenance contract with factory representatives.



12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY AND COMPLETENESS

12.1 Accuracy Assessment - In order to assure the accuracy of the analytical procedures, an environmental sample will be randomly selected from each sample shipment received at the laboratory, and spiked with a known amount of the analyte or analytes to be evaluated. In general, a sample spike will be included in every set of 20 samples tested on each instrument. The spike sample will be then analyzed. The increase in concentration of the analyte observed in the spiked sample, due to the addition of a known quantity of the analyte, compared to the reported value of the same analyte in the unspiked sample determines the percent recovery. Daily control charts will be plotted for each commonly analyzed compound and kept on instrument-specific, matrix - specific, and analyte - specific bases. The percent recovery for a spiked sample is calculated according to the following formula:

$$\% \text{Recovery} = \frac{\text{Amount in Spiked Sample} - \text{Amount in Sample}}{\text{Known Amount Added}} \times 100$$

12.2 Precision Assessment - Spiked samples are prepared by choosing a sample at random from each sample shipment received at the laboratory, dividing the sample into equal aliquots, and then spiking each of the aliquots with a known amount of analyte. The duplicate samples will be then included in the analytical sample set. The splitting of the sample allows the analyst to determine the precision of the preparation and analytical techniques associated with the duplicate sample. The relative percent difference (RPD) between the spike and duplicate spike will be calculated and plotted. The RPD is calculated according to the following formula:

$$\text{RPD} = \frac{\text{Amount in Spike 1} - \text{Amount in Spike 2}}{0.5(\text{Amount in Spike 1} + \text{Amount in Spike 2})} \times 100$$



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12.3 Completeness Assessment - Completeness is the ratio of the number of valid sample results to the total number of samples analyzed with a specific matrix and/or analysis. Following completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$\text{Completeness} = \frac{(\text{number of valid measurements})}{(\text{number of measurements planned})} \times 100$$



13.0 CORRECTIVE ACTION

Corrective action is the process of identifying, recommending, approving and implementing measures to counter unacceptable procedures or out of quality control performance which can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation and data assessment. All corrective action proposed and implemented will be documented in the regular quality assurance reports to management. Corrective action should only be implemented after approval by the CEI Project Manager, or his/her designee, the Site Supervisor. If immediate corrective action is required, approvals secured by telephone from the Project Manager should be documented in the field log book and a subsequent memorandum, issued internally to CEI project management personnel.

For noncompliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. The person who identifies the problem will be responsible for notifying the CEI Project Manager, who in turn will notify the EPA Remedial Project Manager. Implementation of corrective action will be confirmed in writing through the same channels.

Any nonconformance with the established quality control procedures in the *QAPP* or *Site Investigation Work Plan* will be identified and corrected in accordance with the *QAPP*. The EPA Remedial Project Manager, or his/her designee, will issue a nonconformance report for each nonconformance condition.

Corrective actions will be implemented and documented in the field log book. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are insufficient, work may be stopped, at the discretion of CEI management.



13.1 Field Corrective Action - Corrective action in the field can be needed when the sample network is changed (i.e., more/less samples, sampling locations other than those specified in the *QAPP*, etc.), sampling procedures and/or field analytical procedures require modification, etc. due to unexpected conditions. Technical staff and project personnel will be responsible for reporting all suspected technical or QA nonconformances or suspected deficiencies of any activity or issued document by reporting the situation to the Project Manager or designee. This manager will be responsible for assessing the suspected problems in consultation with the Project QA Manager on making a decision based on the potential for the situation to impact the quality of the data. If it is determined that the situation warrants a reportable nonconformance requiring corrective action, then a nonconformance report will be initiated by the Project Manager.

The Project Manager will be responsible for ensuring that corrective action for nonconformances are initiated by:

- evaluating all reported nonconformances;
- controlling additional work on nonconforming items;
- determining disposition or action to be taken;
- maintaining a log of nonconformances;
- reviewing nonconformance reports and corrective actions taken;
- ensuring nonconformance reports are included in the final site documentation in project files.

If appropriate, the Site Supervisor will ensure that no additional work that is dependent on the nonconforming activity is performed until the corrective actions are completed. Corrective action for field measurements may include:

- Repeat the measurement to check the error;
- Check for all proper adjustments for ambient conditions such as temperature;



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Section 13.0

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- Check the source of power;
- Re-Calibration;
- Check the calibration;
- Replace the instrument or measurement devices;
- Stop work (if necessary).

The CEI Site Supervisor is responsible for all site field sampling activities. In this role, the Site Supervisor at times is required to adjust the site programs to accommodate site specific needs. When it becomes necessary to modify a program, the responsible person notifies the Project Manager of the anticipated change and implements the necessary changes after obtaining the approval of the Project Manager. The change in the program will be documented in the field logbook. The Project Manager must approve the change in writing or verbally prior to field implementation, if feasible. If unacceptable, the action taken during the period of deviation will be evaluated in order to determine the significance of any departure from established program practices and action taken.

The Project Manager is responsible for the controlling, tracking, and implementation of the identified changes. Reports on all changes will be distributed to all affected parties which include the EPA RPM. The RPM will be notified whenever significant changes from the field activities outlined in the *Site Investigation Work Plan* are made.

Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods. The CEI QA Manager will identify deficiencies and recommended corrective action to the Project Manager. Implementation of corrective actions will be performed by the Site Supervisor and field crews. Corrective action will be documented in quality assurance reports to all CEI project management personnel.



Corrective actions will be implemented and documented in the field log book. No staff member will initiate corrective action without prior communication of findings through the proper channels.

13.2 Laboratory Corrective Action - Corrective action in the laboratory may occur prior to, during and after initial analyses. A number of conditions such as broken sample containers, multiple phases, low/high pH readings, potentially high concentration samples may be identified during sample log-in or just prior to analysis. Following consultation with lab analysts and department managers, it may be necessary for the GLA Quality Assurance Manager to approve the implementation of corrective action. GLA's SOPs specify some conditions during or after analysis that may automatically trigger corrective action or optional procedures. These conditions may include dilution of samples, additional sample extract cleanup, automatic reinjection/reanalysis when certain quality control criteria are not met, etc. A summary of method-specific corrective actions are found in the GLA SOPs and Section 9 of GLA's *Quality Assurance Program*.

13.3 Corrective Action During Data Validation and Data Assessment - The facility may identify the need for corrective action during either the data validation or data assessment. Potential types of corrective action may include resampling by the field team or reinjection/reanalysis of samples by the laboratory.

These actions are dependent upon the ability to mobilize the field team, whether the data to be collected is necessary to meet the required quality assurance objectives (e.g. the holding time for samples is not exceeded, etc.). When the CEI QA Manager identifies a corrective action situation, it is the Project Manager who will be responsible for approving the implementation of corrective action, including resampling, during data assessment. All corrective actions of this type will be documented by the QA Manager.



14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

14.1 Contents of Project QA Report - The deliverables associated with the tasks identified in the *Site Investigation Work Plan* and monthly progress reports will contain separate QA sections in which data quality information collected during the task is summarized. Those reports will be the responsibility of the Project Manager and will include the CEI QA Manager report on the accuracy, precision, and completeness of the data as well as the results of the performance and system audits, and any corrective action needed or taken during the project.

14.2 Frequency of QA Reports - The QA reports will contain on a routine basis all results of field and laboratory audits, all information generated during the past month reflecting on the achievement of specific data quality objectives, and a summary of corrective action that was implemented, and its immediate results on the project. The status of the project with respect to the Project Schedule included in the *QAPP* will be determined. Whenever necessary, updates on training provided, changes in key personnel, anticipated problems in the field or lab for the coming month that could bear on data quality along with proposed solutions, will be reported. Detailed references to *QAPP* modifications will also be highlighted. All QA reports will be prepared in written, final format by the Project Manager or his designee.

In the event of an emergency, or in case it is essential to implement corrective action immediately, QA reports can be made by telephone to the appropriate individuals, as identified in the Project Organization or Corrective Action sections of this *QAPP*. However, these events, and their resolution will be addressed thoroughly in the next issue of the monthly QA report.



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14.3 Individuals Receiving/Reviewing QA Reports - All CEI individuals identified in the Project Organization chart will receive copies of the monthly QA report. Sections of the QA report which may pertain to GLA will be forwarded to the GLA QA Manager.



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APPENDIX A

Figures

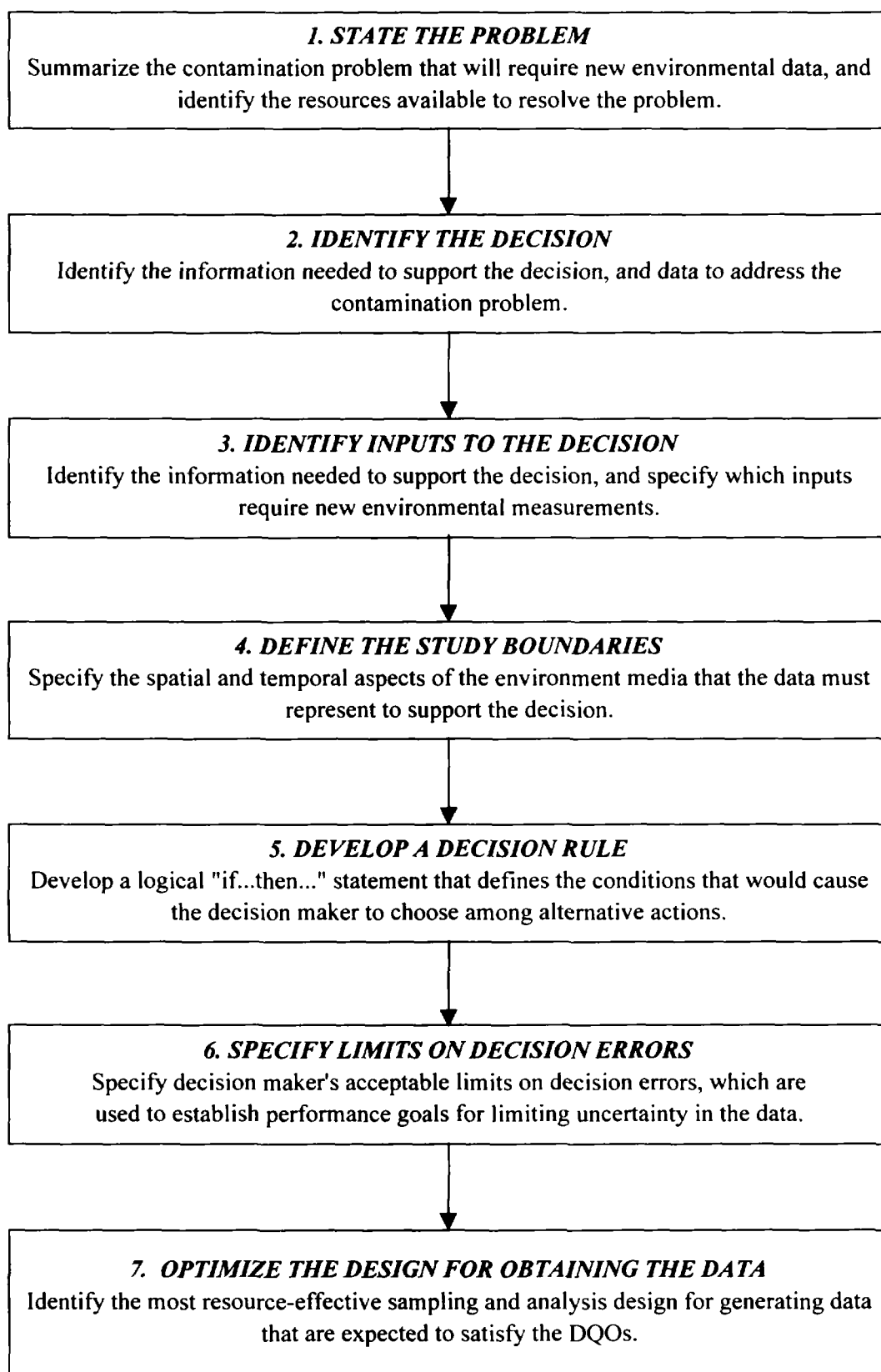


FIGURE 1.1 THE DATA QUALITY OBJECTIVES PROCESS

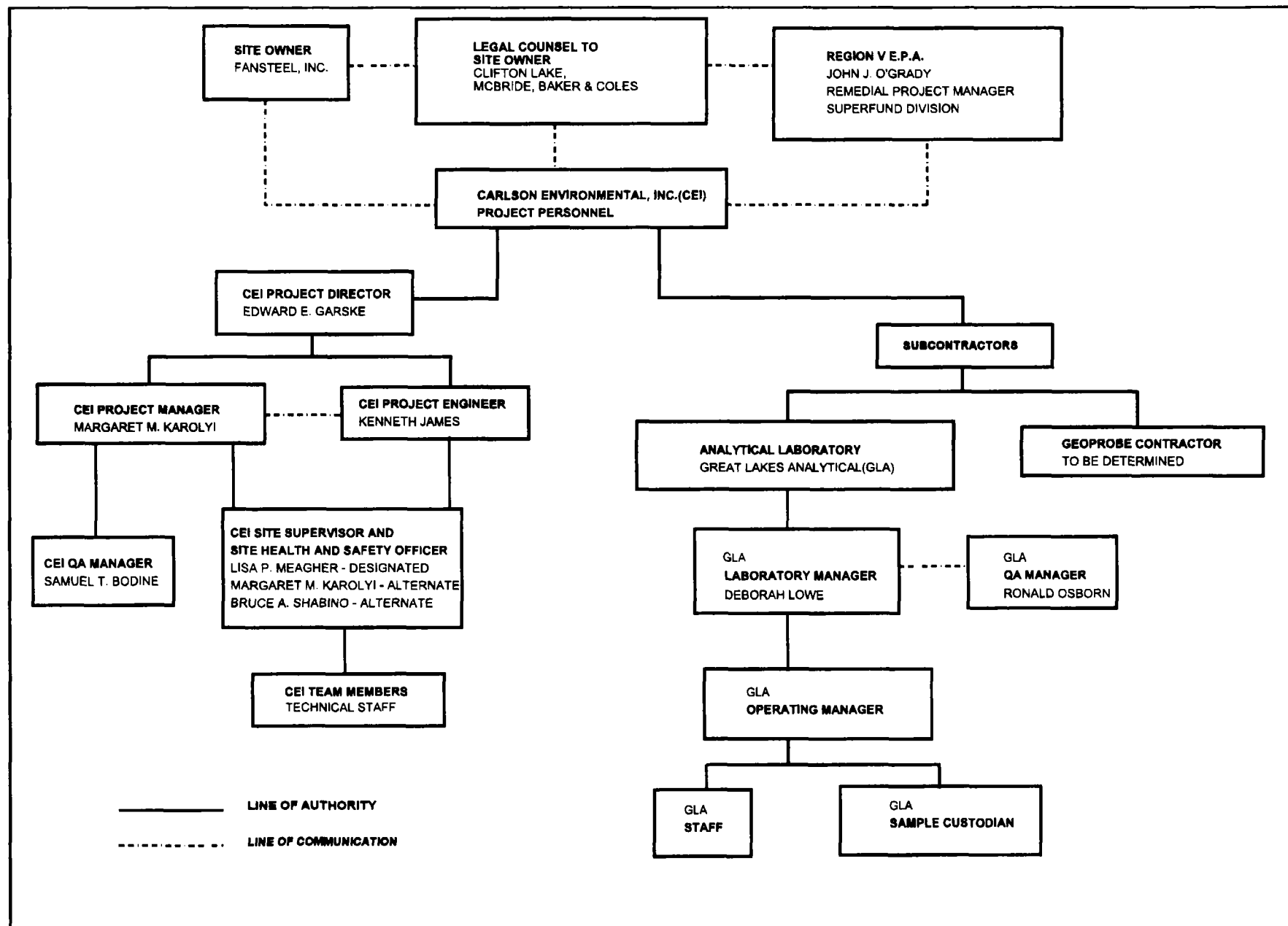


FIGURE 2.1 PROJECT ORGANIZATION DIAGRAM



CARLSON ENVIRONMENTAL, INC.

APPENDIX B

Tables

TABLE ONE: Site Investigation Sampling Summary
Fansteel, Inc.

Matrix	Parameter	EPA SW-846 Method	Sample Collection Points	Minimum Number of Samples	Number of Field Duplicates	MS/MSD Samples	Number and Type of Sample Containers	Preservation Method	Holding Time	Field Parameters
Soil	VOCs	5035/ 8260A	33 Borings	66 plus 25 from 0-12 inches	9	9	one 5g and one 25 g En Core Sample Container	Cool. Laboratory will handle samples in accordance with 5035 Methods	14 days	location, boring log, FID/PID reading, visual classification, note of obvious staining or odor
	Percent Moisture	7.3.3.1.5					one 4-oz glass jar	Cool	7 days	
	Pb, Cd, & Ta	3050/ 6010/ 7060		33 plus 25 from 0-12 inches	6	6	one 4-oz glass jar	Cool	6 months	
	SPLP Pb	1311/ 7421							28 days	
	pH	9045							immediate	
	TOC	9060A	Selected Soil Borings	5	0	0	one 4-oz glass jar	Cool	14 days	
Ground Water	VOCs	5030/ 8260A	9 Monitoring Wells	9	1	1	three glass 40-mL vials	Cool, HCl	14 days	location, conductivity, pH, temperature, water level
	Pb, Cd, & Ta	3050/ 6010/ 7000 Series					two 500-mL plastic	Cool, HNO ₃	6 months	

TABLE ONE: Site Investigation Sampling Summary
Fansteel, Inc.

Matrix	Parameter	EPA SW-846 Method	Sample Collection Points	Minimum Number of Samples	Number of Field Duplicates	MS/MSD Samples	Number and Type of Sample Containers	Preservation Method	Holding Time	Field Parameters	
Creek Sediment	VOCs	5035/ 8260A	7 Creek Bottom Locations, 2 Outfall Locations	18	2	2	one 5g and one 25 g En Core Sample Container	Cool. Laboratory will handle samples in accordance with 5035 Methods	14 days	location, presence of water, FID/PID reading, note of obvious odor or staining	
	Percent Moisture	7.3.3.1.5					one 4-oz glass jar	Cool	7 days		
	23 TAL Metals and Ta	3050/ 6010/ 7000 Series					one 4-oz glass jar	Cool	6 months (except Hg is 28 days)		
	SPLP Pb	1311/ 7421					one 4-oz glass jar	Cool	28 days		
	pH	9045							immediate		
	CN	9012							14 days		
	PNAs	8310					one 4-oz glass jar	Cool	14 days		
	PCBs	8081									
	Pesticides	8081									

TABLE ONE: Site Investigation Sampling Summary
Fansteel, Inc.

Matrix	Parameter	EPA SW-846 Method	Sample Collection Points	Minimum Number of Samples	Number of Field Duplicates	MS/MSD Samples	Number and Type of Sample Containers	Preservation Method	Holding Time	Field Parameters	
Ditch Sediment	VOCs	5035/8260A	One Ditch Locaiton	2	1	1	one 5g and one 25 g En Core Sample Container	Cool. Laboratory will handle samples in accordance with 5035 Methods	14 days	location, presence of water, FID/PID reading, note of obvious odor or staining	
	Percent Moisture	7.3.3.1.5					one 4-oz glass jar	Cool	7 days		
	23 TAL Metals and Ta	3050/6010/ 7000 Series					one 4-oz glass jar	Cool	6 months (except Hg is 28 days)		
	SPLP Pb	1311/ 7421					one 4-oz glass jar	Cool	28 days		
	pH	9045							immediate		
	CN	9012							14 days		
	PNAs	8310					one 4-oz glass jar	Cool	14 days		
	PCBs	8081									

TABLE ONE: Site Investigation Sampling Summary
Fansteel, Inc.

Matrix	Parameter	EPA SW-846 Method	Sample Collection Points	Minimum Number of Samples	Number of Field Duplicates	MS/MSD Samples	Number and Type of Sample Containers	Preservation Method	Holding Time	Field Parameters
Field Blanks (Water)	VOCs	5030/ 8260A	distilled water poured over a clean sampling instrument (e.g. split spoon or bailer)	One sample per day for each of the parameters that the samples collected on that day will also be analyzed for	N/A	N/A	40 mL vial	Cool. Laboratory will handle samples in accordance with 5035 Methods	14 days	N/A
	Pb, Cd, & Ta	3050/ 6010/ 7000 Series			Note: do not submit sample if submitting 23 TAL Metals sample		two 500-mL plastic	Cool, HNO ₃	6 months	
	23 TAL Metals and Ta	3050/ 6010/ 7000 Series			N/A	N/A			two 500-mL plastic	
	SPLP Pb	1311/ 7421					two 500-mL plastic	Cool		
	CN	9012								
	PCBs	8081								
	Pesticides	8081								
	PNA's	8310					1-L amber			

TABLE ONE: Site Investigation Sampling Summary
Fansteel, Inc.

Matrix	Parameter	EPA SW-846 Method	Sample Collection Points	Minimum Number of Samples	Number of Field Duplicates	MS/MSD Samples	Number and Type of Sample Containers	Preservation Method	Holding Time	Field Parameters
Trip Blanks (Water)	VOCs	8260A	prepared by analytical laboratory using deionized water	One sample per day	N/A	N/A	40 mL vial	HCl	14 days	N/A

TABLE THREE: Soil and Sediment Action Levels -TAL Metals/Ta/CN
Fansteel, Inc.

All concentrations are expressed in milligrams per kilogram (mg/kg)

ANALYTE	ACTION LEVEL ¹	REPORTING LIMIT ²
Aluminum	detect	10
Arsenic	3	2.5
Antimony	5	5.0
Barium	260	25
Beryllium	1	0.50
Cadmium	1.0	0.50
Calcium	detect	10
Chromium	28	0.50
Cobalt	12,000	2.5
Copper	330	2.5
Iron	detect	2.5
Lead	400	2.5
Magnesium	detect	10
Manganese	8,700	2.5
Mercury	0.01	0.01
Nickel	20	2.5
Potassium	detect	10
Selenium	2.4	0.50
Silver	0.24	2.5
Sodium	detect	10
Tantalum	detect	5.0
Thallium	1.6	1.6
Vanadium	980	2.5
Zinc	1,000	25
CN	4,100	0.25
SPLP Lead	0.0075	0.0075

¹ Action Level represents the most stringent of the TACO Tier 1 remediation objectives for industrial/commercial properties with Class I ground water.

² Reporting Limit represents the analytical laboratory reporting limit (refer to GLA's QAPP for more information).

detect - Since a TACO Tier 1 remediation objective has not been established, the reporting limit will be applied as the action level.

TABLE EIGHT: Site Investigation - Estimated Schedule of Tasks

Fansteel, Inc.
North Chicago, Illinois

Activity	Time Frame	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Site Investigation Preliminary Activities									
Reserve GeoProbe and Personnel	3 Weeks								
Order Sampling Containers	2 Weeks								
Mark Site Utilities	2 Weeks								
Site Investigation Field Activities									
Boring and Well Installation	8 Days								
Well Development	3 Days								
Creek Sampling	2 Days								
Well Sampling	1 Day								
Topographic Survey	2 Days								

TABLE EIGHT: Site Investigation - Estimated Schedule of Tasks

Fansteel, Inc.
North Chicago, Illinois

Activity	Time Frame	Duration	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18
Site Investigation Laboratory Analysis																	
Laboratory Analysis	2 Weeks	5 Weeks															
Receipt of Final Lab Results																	
Preparation of Data Quality Package		4 Weeks															
Data Evaluation																	
Evaluate Results		4 Weeks															
Calculate Site-Specific Objectives		4 Weeks															
Design Extent of Contamination Investigation		4 Weeks															

TABLE EIGHT: Site Investigation - Estimated Schedule of Tasks

Fansteel, Inc.
North Chicago, Illinois

Activity	Time Frame	Duration	Week 19	Week 20	Week 21	Week 22	Week 23	Week 24	Week 25	Week 26	Week 27	Week 28	Week 29	Week 30	Week 31	Week 32	Week 33	Week 34	Week 35
Extent of Contamination Preliminary Activities																			
Reserve GeoProbe and Personnel	3 Weeks																		
Order Sampling Containers	2 Weeks																		
Mark Site Utilities	2 Weeks																		
Extent of Contamination Investigation																			
Field Activities	6 Weeks																		
Receive Laboratory Analysis	5 Weeks	2 Weeks																	
Evaluate Laboratory Results		3 Weeks																	
Revise Tier 2/Tier 3 Analyses		4 Weeks																	

TABLE EIGHT: Site Investigation - Estimated Schedule of Tasks

Fansteel, Inc.
North Chicago, Illinois

Activity	Time Frame	Duration	Week 34	Week 35	Week 36	Week 37	Week 38	Week 39	Week 40	Week 41	Week 42	Week 43	Week 44	Week 45	Week 46	Week 47	Week 48
Report Preparation																	
Site Drawings, Boring Logs, etc.		4 Weeks															
Summarize Lab Results		4 Weeks															
Site Investigation Report (draft)		6 Weeks															
Site Investigation Report (final)		3 Weeks															



CARLSON ENVIRONMENTAL, INC.

APPENDIX C

CEI SOPs

List of SOPs submitted with QAPP
Fansteel, Inc.
North Chicago, Illinois

SOP ID#	Name	Version	Revision Date
FW- S- 001	Soil Sampling - General	2.0	October 22, 1998
FW- S- 005	Ground Water Monitoring Well Installation	2.0	October 19, 1998
FW- S- 006	Ground Water Monitoring Well Development	2.0	October 19, 1998
FW- S- 007	Sampling Equipment - Decontamination	2.0	November 18, 1998
FW- C- 004	Sediment Sampling	2.0	October 20, 1998
FW- C- 006	Ground Water Sampling - General	1.0	October 20, 1998
FW- C- 010	Disposal Sample Collection (from Drums)	2.0	November 18, 1998
FW- R- 001	Completing Soil Boring Logs	2.0	August 24, 1998
FW- R- 002	Completing Well Installation Logs	2.0	August 25, 1998
FW- R- 003	Chain-of-Custody Procedures	2.0	August 28, 1998

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Soil Sampling - General

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SOP # FW-S-001

REVISION DATE: October 22, 1998

1.0 Scope and Application

The purpose of this standard operating procedure (SOP) is to describe the procedures for the collection of representative soil samples. Analysis of soil samples may determine whether concentrations of specific pollutants exceed established action levels, or if the concentrations of pollutants present a risk to public health, welfare, or the environment.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) or Carlson Environmental, Inc. (CEI) endorsement or recommendation for use.

2.0 Method Summary

Soil samples may be collected using a variety of methods and equipment. The methods and equipment used are dependent on the depth of the desired sample, the type of sample required (disturbed vs. undisturbed), and the soil type. Near-surface soils may be easily sampled using a spade, trowel, and scoop. Sampling at greater depths may be performed using a hand auger, continuous flight auger, a trier, a split-spoon, or, if required, a backhoe.

3.0 Sample Preservation, Containers, Handling and Storage

Chemical preservation of solids is not generally recommended. Samples should, however, be cooled and protected from sunlight to minimize any potential reaction.

If field preservation for VOCs is to be conducted in accordance with EPA Method 5035, please refer to CEI SOP # FW-C-011 for additional information.

4.0 Potential Problems

There are two primary interferences or potential problems associated with soil sampling. These include cross contamination of samples and improper sample collection. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection can involve using contaminated equipment, disturbance of the matrix resulting in compaction of the sample or inadequate homogenization of the samples where required, resulting in variable, non-representative results.

5.0 Equipment/Apparatus

Soil sampling equipment includes the following:

- Sampling plan
- Maps/plot plan
- Safety equipment, as specified in the Health and Safety Plan
- Survey equipment
- Tape measure
- Survey stakes or flags
- Camera and film
- Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan
- Appropriate size sample containers
- Ziplock plastic bags
- Logbook
- Labels
- Chain of Custody records and seals
- Field data sheets
- Cooler(s)
- Ice
- Vermiculite
- Decontamination supplies/equipment
- Canvas or plastic sheet
- Spade or shovel
- Spatula
- Scoop
- Plastic or stainless steel spoons
- Trowel

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Soil Sampling - General

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- Continuous flight (screw) auger
- Bucket auger
- Post hole auger
- Extension rods
- T-handle
- 5-gram and 25-gram Encore™ Samplers
- Sampling trier
- Thin wall tube sampler
- Split spoons
- Vehimeyer soil sampler outfit
 - Points
 - Drive head
 - Drop hammer
 - Puller jack and grip
- Backhoe

6.0 Reagents

Reagents are not used for the preservation of soil samples. Decontamination solutions are specified in the Sampling Equipment Decontamination SOP # FW-S-007 and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.
6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors, including extent and nature of contaminant should be considered when selecting sample

location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations will be utility-cleared by the property owner prior to soil sampling.

7.2 Sample Collection

7.2.1 Surface Soil Samples

Collection of samples from near-surface soil can be accomplished with tools such as spades, shovels, trowels, and scoops. Surface material can be removed to the required depth with this equipment, then a stainless steel or plastic scoop can be used to collect the sample.

This method can be used in most soil types but is limited to sampling near surface areas. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. A stainless steel scoop, lab spoon, or plastic spoon will suffice in most other applications. The use of a flat, pointed mason trowel to cut a block of the desired soil can be helpful when undisturbed profiles are required. Care should be exercised to avoid use of devices plated with chrome or other materials. Plating is particularly common with garden implements such as potting trowels. The following procedure is used to collect surface soil samples:

1. Carefully remove the top layer of soil or debris to the desired sample depth with a pre-cleaned spade.
2. Using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area which came in contact with the spade.
3. If volatile organic analysis is to be performed using Encore™ samplers, refer to Section 7.2.3.1. If volatile organic analysis is to be performed using field preservation with Method 5035, refer to SOP # FW-C-011. If method 5035 is not to be used and volatile organic

analysis is to be performed using Method 8260, transfer the sample directly into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval or location into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.2 Sampling at Depth with Augers and Thin Wall Tube Samplers

This system consists of an auger, or a thin-wall tube sampler, a series of extensions, and a "T" handle. The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the auger. If a core sample is to be collected, the auger tip is then replaced with a thin wall tube sampler. The system is then lowered down the borehole, and driven into the soil to the completion depth. The system is withdrawn and the core is collected from the thin wall tube sampler.

Several types of augers are available; these include: bucket type, continuous flight (screw), and post-hole augers. Bucket type augers are better for direct sample recovery since they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights. The continuous flight augers are satisfactory for use when a composite of the complete soil column is desired. Post-hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy soil and cannot be used below a depth of three feet.

The following procedure will be used for collecting soil samples with the auger:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.
2. Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). It may be advisable to remove the first three to six inches of surface soil for an area approximately six inches in radius around the drilling location. After reaching the desired depth, slowly and carefully remove the auger from boring. When sampling directly from the auger, collect the sample after the auger is removed from the boring and proceed to Step 10.
3. Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.
4. After reaching the desired depth, slowly and carefully remove the auger from boring. When sampling directly from the auger, collect the sample after the auger is removed from the boring and proceed to Step 10.
5. Remove auger tip from drill rods and replace with a pre-cleaned thin wall tube sampler. Install the proper cutting tip.
6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into soil. Care should be taken to avoid scraping the borehole sides. Avoid hammering the drill rods to facilitate coring as the vibrations may cause the boring walls to collapse.
7. Remove the tube sampler, and unscrew the drill rods.
8. Remove the cutting tip and the core from the device.
9. Discard the top of the core (approximately 1 inch), as this possibly represents material

collected before penetration of the layer of concern. Place the remaining core into the appropriate labeled sample container. Sample homogenization is not required.

10. If volatile organic analysis is to be performed using Encore™ samplers, refer to Section 7.2.3.1. If volatile organic analysis is to be performed using field preservation with Method 5035, refer to SOP # FW-C-011. If method 5035 is not to be used and volatile organic analysis is to be performed using Method 8260, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent, and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly.

When compositing is complete, place the sample into appropriate, labeled containers and sample into appropriate, labeled containers secure the caps tightly.

11. If another sample is to be collected in the same hole, but at a greater depth, reattach the auger bit to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the auger and tube sampler between samples.
12. Abandon the hole according to applicable State regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

7.2.3 Sampling at Depth with a Trier

The system consists of a trier, and a "T" handle. The auger is driven into the soil to be sampled and used to extract a core sample from the appropriate depth.

The following procedure will be used to collect soil samples with a sampling trier:

1. Insert the trier into the material to be sampled at a 0 to 45 angle from horizontal. This orientation minimizes the spillage of sample.
2. Rotate the trier once or twice to cut a core of material.
3. Slowly withdraw the trier, making sure that the slot is facing upward.
4. If volatile organic analysis is to be performed using Encore™ samplers, refer to Section 7.2.3.1. If volatile organic analysis is to be performed using field preservation with Method 5035, refer to SOP # FW-C-011. If method 5035 is not to be used and volatile organic analysis is to be performed using Method 8260, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.3 Encore™ Sampling with a Trier

This method should be used whenever volatile organic sampling is to be conducted using Encore™ samplers. The filled Encore™ samplers will be submitted to the laboratory. The laboratory will extract the sample from the Encore™ sampler and conduct the preservation required by Method 5035.

The Encore™ samplers come in two sizes - 5 gram and 25 gram. One sampler of each size should be used per desired sample interval. The Encore™

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sampler comes from the laboratory in a sealed silver foil-type bag that is resealable.

1. Open the bag should and retrieve the two-piece sampler assembly.
2. Attach the plunger portion of the assembly to the trier dedicated to Encore™ sampling. This is achieved by pressing the spring mechanism down while loading the plunger assembly into the bottom of the trier.
3. Press the trier/assembly into the desired soil sample until the plunger mechanism becomes viewable in the viewing holes located on the trier. The lowest viewing hole corresponds to the 5-gram sampler and the highest viewing hole corresponds to the 25-gram sampler.
4. Cap the sampler and tighten the cap by screwing it clockwise. Press the spring mechanism to release the capped sampler from the trier.
5. Place the capped sampler in the foil-type bag it was removed from and re-seal the bag. Write the sample information on the label attached to the bag.
6. Place the bag in the sample cooler.

Note: A dry weight sample needs to be submitted with the Encore™ samplers, for laboratory analysis. This sample should be placed in a 2-ounce or 4-ounce glass jar and requires no preservative.

7.2.4 Sampling at Depth with a Split Spoon (Barrel) Sampler

The procedure for split spoon sampling describes the collection and extraction of undisturbed soil cores of 18 or 24 inches in length. A series of consecutive cores may be extracted with a split spoon sampler to give a complete soil column profile, or an auger may be used to drill down to the desired depth for sampling. The split spoon is then driven to its sampling depth through the bottom of the augured hole and the core extracted.

When split spoon sampling is performed to gain geologic information, all work should be performed in accordance with ASTM D 1586-67 (reapproved 1974).

The following procedures will be used for collecting soil samples with a split spoon:

1. Assemble the sampler by aligning both sides of barrel and then screwing the drive shoe on the bottom and the head piece on top.
2. Place the sampler in a perpendicular position on the sample material.
3. Using a well ring, drive the tube. Do not drive past the bottom of the head piece or compression of the sample will result.
4. Record in the site logbook or on field data sheets the length of the tube used to penetrate the material being sampled, and the number of blows required to obtain this depth.
5. Withdraw the sampler, and open by unscrewing the bit and head and splitting the barrel. The amount of recovery and soil type should be recorded on the boring log. If a split sample is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally. This sampler is typically available in 2 and 3 ½ inch diameters. However, in order to obtain the required sample volume, use of a larger barrel may be required.
6. Without disturbing the core, transfer it to appropriate labeled sample container(s) and seal tightly.

7.2.5 Sampling at Depth with a GeoProbe Sampler

The following procedures will be used for collecting soil samples with a GeoProbe:

1. The drilling contractor will assemble the sampler - which includes either a 24-inch or 48-inch long cellulose acetate butyrate (CAB) sampling sleeve.

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2. Place the sampler in a perpendicular position on the sample material.
3. Using the GeoProbe hydraulic system, drive the tube. Do not drive past the bottom of the head piece or compression of the sample will result.
4. Record in the site logbook or on field data sheets the length of the tube used to penetrate the material being sampled.
5. The GeoProbe contractor will withdraw the sampler. The CAB sleeve will be slit open to expose the soil sample, using a razor-blade type of utility knife. The amount of recovery and soil type should be recorded on the boring log. If a split sample is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally.
6. Without disturbing the core, transfer it to appropriate labeled sample container(s) and seal tightly.
3. A shovel is used to remove a one to two inch layer of soil from the vertical face of the pit where sampling is to be done.
4. Samples are taken using a trowel, scoop, or coring device at the desired intervals. Be sure to scrape the vertical face at the point of sampling to remove any soil that may have fallen from above, and to expose fresh soil for sampling. In many instances, samples can be collected directly from the backhoe bucket.
5. If volatile organic analysis is to be performed using Encore™ samplers, refer to Section 7.2.3.1. If volatile organic analysis is to be performed using field preservation with Method 5035, refer to SOP # FW-C-011. If method 5035 is not to be used and volatile organic analysis is to be performed using Method 8260, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.6 Test Pit/Trench Excavation

These relatively large excavations are used to remove sections of soil, when detailed examination of soil characteristics (horizontal, structure, color, etc.) are required. It is the least cost effective sampling method due to the relatively high cost of backhoe operation.

The following procedures will be used for collecting soil samples from test pit/trench excavations:

1. Prior to any excavation with a backhoe, it is important to ensure that all sampling locations are clear of utility lines, subsurface pipes and poles (subsurface as well as above surface).
2. Using the backhoe, a trench is dug to approximately three feet in width and approximately one foot below the cleared sampling location. Place excavated soils on plastic sheets. Trenches greater than five feet deep must be sloped or protected by a shoring system, as required by OSHA regulations.
6. Abandon the pit or excavation according to applicable state regulations. Generally, shallow excavations can simply be backfilled with the removed soil material.

8.0 Calculations

This section is not applicable to this SOP.

9.0 Quality Assurance/Quality Control

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There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

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1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 Data Validation

This section is not applicable to this SOP.

11.0 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

12.0 References

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Ground Water Monitoring Well Installation Page 1

SOP # FW-S-005

REVISION DATE: October 19, 1998

1.0 Scope and Application

The purpose of this standard operating procedure (SOP) is to provide an overview of the methods used for groundwater monitor wells. Monitor well installation create permanent access for collection of samples to assess groundwater quality and the hydrogeologic properties of the aquifer in which contaminants may exist. Such wells should not alter the medium which is being monitored.

The most commonly used drilling methods are: the hollow-stem auger, cable tool, and hydraulic rotary. Rotary drilling can utilize mud rotary or air rotary methods.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, depending on site conditions, equipment limitations, or limitations imposed by the procedures themselves. In all instances, the ultimate procedures employed should be documented and described in the final report as well as in logbooks.

Mention of trade names or commercial products does not constitute United States Environmental Protection Agency (U.S. EPA) or Carlson Environmental, Inc. (CEI) endorsement or recommendation for use.

2.0 Method Summary

There is no ideal monitoring well installation method for all conditions therefore, hydrogeologic conditions at the site as well as project objectives must be considered before deciding which drilling method is appropriate.

2.1 Hollow-Stem Augering and GeoProbing

Outside diameters of hollow-stem augers generally range from 6 1/4 inches to 22 inches with corresponding inner diameters ranging from 2 1/4 inches to 13 inches. Auger lengths are usually 5 feet which allows easy handling. However, lengths of 10 or 20 feet may be used for deeper holes drilled with machines capable of handling the extended lengths.

GeoProbe samplers range in length but are commonly used in 2-foot, 4-foot or 5-foot lengths. The sampler assembly is equipped with a cellulose acetate butyrate (CAB) sampling sleeve which can be cut upon to expose the sample core (similar to splitting open the split-spoon sampler). The inner diameters of the CAB sleeves are typically one or two inch diameters. The resulting borehole produced by the GeoProbe can vary from two-inches to approximately five inches in diameter.

Formation samples can be taken in a number of ways, depending on the accuracy required. Cuttings may suffice for shallow depths but become less representative with depth, particularly below the water table. The most accurate samples are obtained with various coring devices, such as split spoons or shelby tubes which can be used inside the augers. Continuous cores can also be taken with a thin-walled tube which is inserted into the lowest auger and locked in place. The tube is retracted with a wire line and hoist after the hole has been advanced the length of the auger. A bottom plug in the cutting head or bit prevents cuttings from entering the augers until the first core sample is taken and the plug is knocked out.

In unconsolidated material, the augers serve as a temporary casing and gravel-packed wells can be constructed inside the augers and then the augers withdrawn. Well development is usually less difficult than with wells drilled by the mud rotary method because a bentonite drilling fluid is not normally used.

2.2 Cable Tool Drilling

Cable tool drilling is a percussion method in which a bit, attached to a drilling string, is lifted and dropped. The drilling string, consists (bottom to top) of the bit, drill stem, drilling jars, socket, and wire cable. A walking beam on the drilling rig provides the lifting and dropping motion to the wire cable and hence to the drilling string. The repeated action breaks or loosens the formation material which mixes with formation water or water added to the hole by the operator to form a slurry. The slurry

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facilitates removal of the cuttings which are periodically removed from the hole with a bailer. In unconsolidated formations, steel casing must be driven or pushed into the ground as the drilling progresses in order to prevent hole collapse. A hardened steel drive shoe on the bottom end of the casing prevents damage during driving. A well may then be constructed inside the steel casing and the casing pulled back. In consolidated formations, the casing may be driven through the weathered zone, and seated in solid rock. The hole below the casing may remain open or may be fitted with a smaller diameter inner casing and screen, depending on the sampling requirements. Depending on formation material, extensive well development may often not be necessary.

2.3 Rotary Drilling

2.3.1 Mud Rotary Method

In the mud rotary method the drill bit is rotated rapidly to cut the formation material and advance the borehole. The drill bit is attached to hollow drilling rods which transfer power from the rig to the bit. In conventional rotary drilling, cuttings are removed by pumping drilling fluid (water, or water mixed with bentonite or other additives) down through the drill rods and bit, and up the annulus between the borehole and the drill rods. The drilling fluid flows into a mud pit where the cuttings settle out and then is pumped back down the drill rods. The drilling fluid also cools the bit and prevents the borehole from collapsing in unconsolidated formations.

Sampling may be done from the cuttings but samples are generally mixed and the amount of fine material may not be accurately represented. Coring may be done through the drill rods and bit if a coring bit (with a center opening big enough to allow passage of the coring tube) is used. When drilling unconsolidated formations, a temporary surface or shallow casing may have to be installed in order to prevent cross-contamination, hole collapse, or wall erosion by the drilling fluid. Casing (riser pipe), screen, and gravel pack are usually installed in the open hole or through the surface casing. Once

the well is constructed, extensive well development may be necessary in order to remove drilling fluid from the formation.

2.3.2 Air Rotary Method

The air rotary method uses air as the drilling fluid. Air is forced down the drill rods by an air compressor, escapes out of the bit and returns to the surface annular space between the hole wall and the drill string. Cuttings are moved out of the hole by the ascending air and collect around the rig. Cuttings are mixed and may not always be representative of the depth currently being drilled. In the conventional air rotary method, the drill string operates in a manner similar to that described for the mud rotary system. In a "hammer" or "down-the-hole" air rotary method, the bit is pneumatically driven rapidly against the rock in short strokes while the drilling string slowly rotates. The use of air rotary methods are generally limited to consolidated and semi-consolidated formations. Casing is often used in semi-consolidated formations and through the weathered portion of consolidated formations to prevent hole collapse. In environmental work, the air supply must be filtered to prevent introduction of contamination into the borehole.

3.0 Sample Preservation, Containers, Handling and Storage

Often, a primary objective of the drilling program is to obtain representative lithologic or environmental samples. The most common techniques for retrieving samples are:

In unconsolidated formations:

- Split spoon sampling, carried out continuously or at discrete intervals during drilling, as summarized in ASTM Method D-1586- 84, Split Barrel Sampling
- GeoProbe sampling using CAB sampling sleeves, carried out continuously or at discrete intervals during drilling

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- Shelby tube sampling when an undisturbed sample is required from clayey or silty soils, especially for geotechnical evaluation or chemical analysis
- Cutting collection when a general lithologic description and approximate depths are sufficient

In consolidated formations:

- Rock coring at continuous or discrete intervals
- Cutting collection when a general lithologic description and approximate depths are sufficient

When collecting environmental samples, the amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest. Sample preservation, containers, handling and storage for air and waste samples are discussed in the specific SOPs for the technique selected.

4.0 Interferences and Potential Problems

Advantages and disadvantages of the various drilling methods are summarized below.

4.1 Auger Drilling

The advantages of auger drilling are:

- Relatively fast and inexpensive
- Because augers act as temporary casing, drilling fluids are not used resulting in reduced well development

The disadvantages of auger drilling are:

- Very slow or impossible to use in coarse materials such as cobble or boulders

- Cannot be used in consolidated formations and is generally limited to depths of approximately 100 feet in order to be efficient

4.2 GeoProbing

The advantages of GeoProbing are:

- Relatively fast and inexpensive
- Because GeoProbe rods act as temporary casing, drilling fluids are not used resulting in reduced well development

The disadvantages of auger drilling are:

- Very slow or impossible to use in coarse materials such as cobble or boulders
- Cannot be used in consolidated formations and is generally limited to depths of approximately 50 feet in order to be efficient

4.3 Cable Tool Drilling

The advantages of cable tool drilling are:

- Relatively inexpensive with minimum labor requirements
- The water table and water bearing zones are easily identified
- Driven casing stabilizes borehole and minimizes potential for cross-contamination
- Especially successful in drilling caving formations or formations containing boulders
- Accurate formation samples can usually be obtained from cuttings

The disadvantages of cable tool drilling are:

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- Extremely slow rate of drilling
- Necessity to drive casing may limit depth in large diameter holes.

4.4 Rotary Drilling

4.4.1 Mud Rotary Drilling

The advantages of mud rotary drilling are:

- Fast, more than 100 feet of borehole advancement per day is common
- Provides an open borehole, necessary for some types of geophysical logging and other tests

The disadvantages of mud rotary drilling are:

- Potential for cross-contamination of water- bearing zones
- Drill cuttings may be mixed and not accurately represent lithologies at a given drilling depth
- Drilling mud may alter the groundwater chemistry
- Water levels can only be determined by constructing wells
- Drilling mud may change local permeability of the formation and may not be entirely removed during well development
- Disposal of large volumes of drilling fluid and cuttings may be necessary if they are contaminated

4.4.2 Air Rotary Drilling

The advantages of air rotary drilling are:

- Fast, more than 100 feet of borehole advancement a day is possible

- Preliminary estimates of well yields and water levels are often possible
- No drilling fluid to plug the borehole

The disadvantages of air rotary drilling are:

- Generally cannot be used in unconsolidated formations
- In contaminated zones, the use of high-pressure air may pose a significant hazard to the drill crew because of transport of contaminated material up the hole
- Introduction of air to the groundwater could reduce concentration of volatile organic compounds

5.0 Equipment/Apparatus

The following equipment is necessary for the site geologist:

- Metal clipboard box case (container for well logs)
- Ruler
- Depth sounder
- Water level indicator
- All required health and safety gear
- Sample collection jars
- Trowels
- Description aids (Munsell color chart, grain size charts, etc.)
- Logbooks

Field logbooks, equipment and tools to install the well are normally provided by the drilling contractor. Equipment and tools to install the well are normally provided by the drilling contractor.

6.0 Reagents

Reagents are not required for preservation of soil samples. Samples should, however, be cooled to 4° C and protected from sunlight in order to minimize any potential reaction due to the light sensitivity of the sample. Decontamination of drilling equipment

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should follow the Sampling Equipment Decontamination SOP # FW-S-007 and the site-specific work plan.

7.0 PROCEDURES

7.1 Preparation

All drilling and well installation programs must be planned and supervised by a professional geologist/hydrogeologist.

The planning, selection and implementation of any monitor well installation program should include the following:

- Review of existing data on site geology and hydrogeology including publications, air photos, water quality data, and existing maps. These may be obtained from local, state or federal agencies.
- Assessment of the site to determine potential access problem for drill rig, locate water supply sources, establish equipment storage area, and observe outcrops
- Perform utilities check, note location of underground utilities and of overhead electrical wires
- Preparation of a Site Safety Plan
- Select drilling, sampling and well development methods
- Determination of well construction specifications (i.e., casing and screen materials, casing and screen diameter, screen length and screen interval, filter pack and screen slot size)
- Determination of the need for containing drill cuttings and fluids and their method of disposal

- Preparation of work plan including all of the above
- Preparation and execution of the drilling contract

7.2 Field Preparation

Prior to mobilization, the drill rig and all associated equipment should be thoroughly decontaminated by a steam/pressure washer to remove all oil, grease, mud, etc. Before drilling each boring, all the "down-the-hole" drill equipment should be steam cleaned and rinsed with potable water to minimize cross-contamination. Special attention should be given to the threaded section of the casings, and to the drill rods. All drilling equipment should be steam-cleaned at completion of the project to ensure that no contamination is transported to or from the sampling site.

7.3 Well Construction

The well casing material should not interact with the groundwater. Well casings for environmental projects are usually constructed of polyvinyl chloride (PVC), Teflon, fiberglass, or stainless steel. Details of the construction methods are given in Sections 7.3.1 and 7.3.2.

7.3.1 Bedrock Wells

Wells completed in bedrock will be drilled using the air or mud rotary method. Crystalline rock wells are usually drilled most efficiently with the air rotary method while consolidated sedimentary formations are drilled using either the air rotary or mud rotary method. The compressed air supply will be filtered prior to introduction into the borehole to remove oil or other contaminants. Bedrock wells may be completed as an open-hole, providing that borehole cave-in is not a possibility.

Bedrock wells will be advanced with air or mud rotary methods until a minimum of 5 feet of competent rock has been drilled. Minimum borehole diameter will be 8 inches. The drill string will then be pulled from the borehole and 6-inch I.D.

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Schedule 80 or 40 PVC casing inserted. Portland cement/bentonite grout will be pumped into the hole and up the annular space outside the casing. After the grout has set (minimum of 24 hours), the cement will be drilled out and the borehole advanced to the desired depth. Shows typical construction details for an open-hole bedrock well.

The preferred method of well completion for the bedrock wells will be open-hole. However, if the open borehole is subject to cave-in, the well(s) will be completed as screened and cased sand-packed wells. For details of completion see Section 7.3.2.

7.3.2 Overburden Well Construction

Any of the drilling methods discussed in this SOP can be used to drill or set a well in the overburden. The hollow-stem method is the preferred choice for shallow (<100 ft.) overburden wells because the well can be constructed inside of the augers.

1. The screen slot size will be determined by the site hydrologist, based upon sand-pack size. The length of screen used will be site-dependent. Casing sections will be flush-threaded. Screw-threaded bottom plugs will be used. To prevent introduction of contaminants into the well, no glue-connected fittings will be used. Each piece of PVC pipe, screen, and the bottom plug will be steam-cleaned before lowering into the borehole. The site hydrogeologist is responsible for the supervision of all steam cleaning procedures.
 2. The annular space between the well screen and the borehole wall will be filled with a uniform gravel/sand pack to serve as a filter media. For wells deeper than approximately 50 feet, or when recommended by the site geologist, the sand pack will be emplaced using a tremie pipe. A sand slurry composed of sand and potable water will be pumped through the tremie pipe into the annulus throughout the entire screened interval, and over the top of the screen. Allowance must be made for settlement of the sand pack.
 3. The depth of the top of the sand will be determined using the tremie pipe, thus verifying the thickness of the sand pack. Additional sand shall be added to bring the top of the sand pack to approximately 2 to 3 feet above the top of the well screen. Under no circumstances should the sand pack extend into any aquifer other than the one to be monitored. In most cases, the well design can be modified to allow for a sufficient sand pack without threat of crossflow between producing zones through the sand pack.
 4. In materials that will not maintain an open hole using hollow-stem augers, the temporary or outer casing will be withdrawn gradually during placement of sand pack/grout. For example, after filling two feet with sand pack, the outer casing should be withdrawn 2 feet. This step of placing more gravel and withdrawing the outer casing should be repeated until the level of the sand pack is approximately 3 feet above the top of the well screen. This ensures that there is no locking of the permanent (inner) casing in the outer casing.
 5. A bentonite seal of a minimum 2-foot vertical thickness will be placed in the annular space above the sand pack to separate the sand pack from the cement surface seal. The bentonite will be placed through a tremie pipe or poured directly into the annular space, depending upon the depth and site conditions. The bentonite will be pourable pellets. The hydrogeologist will record the start and stop times of the bentonite seal emplacement, the interval of the seal, the amount of bentonite that was used, and problems that arise. The type of bentonite and the supplier will also be recorded.
- A cap placed over the top of the well casing surface before pouring the bentonite pellets will prevent pellets from entering the well casing.
6. If a slurry of bentonite is used as annular seal, it is prepared by mixing powdered or granular bentonite with potable water. The slurry must be of sufficiently high specific gravity and viscosity to prevent its displacement by the grout to be

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emplaced above it. As a precaution (regardless depth) and depending on fluid viscosity, a few handfuls of bentonite pellets may be added to solidify the bentonite slurry surface.

7. Cement and/or bentonite grout is placed from the top of the bentonite seal to the ground surface.

Only Type I or II cement without accelerator additives may be used. An approved source of potable water must be used for mixing grouting materials. The following mixes are acceptable:

- Neat cement, a maximum of 6 gallons water per 94 pound bag of cement
- Granular bentonite, 1.5 pounds of bentonite per 1 gallon of water
- Cement-bentonite, 5 pounds of pure bentonite per 94 pound bag of cement with 7- 8 gallons of water
- Cement-bentonite, 6- to 8 pounds of pure per 94 gallons of water, if water mixed
- Non-expandable cement, mixed at 7.5 gallons of water to one half (½) teaspoon of Aluminum Hydroxide, 94 pounds of neat cement (Type I) and 4 pounds of bentonite.
- Non-expandable cement, mixed at 7 gallons of water to one half (½) teaspoon of Aluminum Hydroxide, 94 pounds of neat cement (Type I and Type II)

8. Grout is pumped through a tremie pipe (normally a 1.25-inch PVC or steel pipe) to the bottom of the annulus until undiluted grout flows from the annulus at the ground surface
9. In materials that will not maintain an open hole, the temporary steel casing should be withdrawn in a manner that prevents the level of grout from dropping below the bottom of the casing.

10. Additional grout may be added to compensate for the removal of the temporary casing and the tremie pipe to ensure that the top of the grout is at or above ground surface. After the grout has set (about 24 hours), any depression due to settlement is fill with a grout mix similar to that describe above.

11. The protective casing should now be set. Casing may be a 5 foot minimum length of black iron or galvanized pipe extending about 1.5 to 3 feet above the ground surface, and set in concrete or cement grout. The protective casing diameter should be 4 inches greater than the well casing. A 0.5-inch drain hole may be installed near ground level. A flush-mount protective casing may also be used in areas of high traffic or when access to other areas would be limited by a well stick-up.

12. A protective steel cap, secured to the protective casing by a padlock, should be installed

13. Steel guard posts should be installed around the protective casing in areas when vehicle traffic may be a problem. Posts should have a minimum diameter of 3 inches and be a minimum of 4 feet high.

14. All monitor wells should be labeled and dated with paint or steel tags.

7.4 Well Development

Well development is the process by which the aquifer's hydraulic conductivity is restored by removing drilling fluids, and fine-grained formation material from newly installed wells. Two methods of well development that are commonly used are surging and bailing, and overpumping. A well is considered developed when the pH and conductivity of the groundwater stabilizes and the measured turbidity is <50 nephelometric turbidity units (NTUs).

Surging and bailing will be performed as follows:

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1. Measure the total depth (TD) of the well and depth to water (DTW).
2. Using an appropriately sized surge block, surge 5-foot sections of well screen, using 10-20 up/down cycles per section. Periodically remove the surge block and bail accumulated sediment from the well, as required.
3. For open-hole wells, a 6-inch surge block will be used inside the cased portion of the well. Sediments will be bailed periodically, as required. Overpumping may be used in combination with surging and bailing for development of bedrock wells. The method(s) used will be based on field conditions encountered, and will be determined by the site hydrogeologist. However, sediment will initially be removed from the wells by bailing in order to minimize the volume of development water generated.

The pump used must be rated to achieve the desired yield at a given depth. The pump system should include the following:

- A check valve to prevent water from running back into the well when the pump is shut off
- Flexible discharge hose
- Safety cable or rope to remove the pump from the well
- Generator
- Amp meter, to measure electrical current (load)

The amp meter is used to monitor pump performance. If the pump becomes clogged, the current will increase due to stress on the pump. If the water level drops below the intake ports, the current will drop due to decreased resistance on the pump.

8.0 Calculations

To maintain an open borehole during rotary drilling, the drilling fluid must exert a pressure greater than the formation pore pressure. Typical pore pressures for unconfined and confined aquifers are 0.433 define (psi/ft) and 0.465 psi/ft, respectively.

The relationship for determining the hydrostatic pressure of the drilling fluid is:

$$\text{Hydrostatic Pressure (psi)} = \text{Fluid Density (lb/gal)} \times \text{Height of Fluid Column (ft)} \times 0.052$$

The minimum grout volume necessary to grout a well can be calculated using:

$$\text{Grout Vol (ft}^3\text{)} = \text{Vol of Borehole (ft}^3\text{)} - \text{Vol of Casing (ft}^3\text{)} = L (r_b^2 - r_c^2)$$

where:

L = Length of borehole to be grouted (ft)

r_b = radius of boring (ft)

r_c = radius of casing (ft)

9.0 Quality Assurance/Quality Control

There are no specific quality assurance activities that apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on standard well completion forms, field data sheets or within field/site logbooks. Descriptive logs, pump tests, and well completion date should be recorded.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and must be documented.

10.0 Data Validation

This section is not applicable to this SOP.

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11.0 Health and Safety

Drilling rigs and equipment present a variety of safety hazards. CEI personnel should not attempt to operate the drill rigs. All underground utilities should be clearly marked, and drillers should be aware of any overhead hazards such as power lines. Avoid drilling in these areas. Ear protection should be worn when working around drilling equipment for extended periods of time, particularly air rotary equipment. Failure to follow safety procedure or wear the proper personal protection gear on the part of either the drilling crew or CEI personnel may result in dismissal from the job.

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety practices..

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Ground Water Monitoring Well Development Page 1

SOP # FW-S-006

REVISION DATE: October 19, 1998

1.0 Scope and Application

The purpose of this standard operating procedure (SOP) is to provide an overview of monitor well development practices. The purpose of monitor well development is to ensure removal of fines from the vicinity of the well screen. This allows free flow of water from the formation into the well and also reduces the turbidity of the water during sampling events. The most common well development methods are: surging, jetting, over pumping and bailing.

Surging involves raising and lowering a surge block or surge plunger inside the well. The resulting surging motion forces water into the formation and loosens sediment to be pulled from the formation into the well. Occasionally, sediments must be removed from well with a sand bailer to prevent sand locking of the surge block. This method may cause the sand pack around the screen to be displaced to a degree that damages its value as a filtering medium. For example, channels or voids may form near the screen if the filter pack sloughs away during surging (Keely and Boateng, 1987).

Jetting involves lowering a small diameter pipe into the well a few feet above the well screen, and injecting water or air through the pipe under pressure so that sediments at the bottom are geysered out of the top of the well. It is important not to jet air or water directly across the screen. This may cause fines in the well to be driven into the entrance of the screen openings, thereby causing blockages.

Over pumping involves pumping at a rate rapid enough to draw the water level in the well as low as possible, and allowing it to recharge. This process is repeated until sediment-free water is produced.

Bailing includes using a simple check-valve bailer to remove water from the well. The bailing method, like other methods, should be repeated until sediment free water is produced. Bailing may be the method of choice in a shallow well or well that recharges slowly.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA or Carlson Environmental, Inc. (CEI) endorsement or recommendation for use.

2.0 Method Summary

Development of a well should occur as soon as it is practical after installation, but not sooner than 48 hours after grouting is completed, if a rigorous well development method is being used. If a less rigorous method, such as bailing, is used for development, it may be initiated shortly after installation. The main concern is that the method being used for development does not interfere with allowing the grout to set.

3.0 Sample Preservation, Containers, Handling and Storage

This section is not applicable to this (SOP).

4.0 Interferences and Potential Problems

The following interferences or problems may occur during well development:

1. Over pumping is not as vigorous as surging and jetting, and is probably the most desirable method for monitor well development.
2. The possibility of disturbing the filter pack increases with surging and jetting well development methods.
3. The introduction of external water or air by jetting may alter the hydro chemistry of the aquifer.

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5.0 Equipment/Apparatus

The type of equipment used for well development is dependent on the diameter of the well and the development method. For example, the diameter of most submersible pumps is too large to fit in a two-inch inner diameter (I.D.) well and an inertia pump or other development method should be used.

In general, the well should be developed with the drilling equipment shortly after it is drilled. Most drilling rigs have air compressors or pumps that may be used for the development process.

6.0 Reagents

No chemical reagents are used in this procedure; however, decontamination solutions may be necessary. If decontamination of equipment is required at a well, refer to the SOP # FW-S-007 for Sampling Equipment Decontamination and the site specific work plan.

7.0 Procedures

7.1 Preparation

1. Coordinate site access and obtain keys to the locks.
2. Obtain information on each well to be developed (i.e., drilling, method, well diameter, depth, screened interval, anticipated contaminations, etc.).
3. Obtain a water level meter, a depth sounder, air monitoring equipment, materials for decontamination, pH and specific conductivity meters, a thermometer, stopwatch, and development equipment/apparatus.
4. Assemble containers for temporary storage of water produced during well development. Containers must be structurally sound, compatible with anticipated contaminants, and easy to manage in the field. The use of truck-mounted tanks may be necessary in some cases; alternately, a portable water treatment unit (i.e.,

activated carbon) may be used to decontaminate the purge water.

7.2 Operation

Development should be performed as soon as it is practical after the well is installed, but no sooner than 48 hours after grouting is completed. Dispersing agents, acids, or disinfectants should not be used to enhance development of the well.

1. Assemble necessary equipment on a plastic sheet around the well.
2. Record pertinent information in field logbook (personnel, time, location ID, etc.).
3. Open monitor well, take air monitoring reading at the top of casing and breathing zone as appropriate.
4. Measure depth to water and the total depth of the monitoring well.
5. Develop the well until the water is clear and free of sediments. Note the initial color, clarity, and odor of the water.
6. Measure the initial pH, temperature, and specific conductivity of the water and record in logbook.
7. All water produced by development in contaminated or suspected contaminated areas must be containerized or treated. Each container must be clearly labeled with the location ID. Determination of the appropriate disposal method will be based on the first round of analytical results from each well.
8. No water shall be added to the well to assist development without prior approval by appropriate personnel. If a well cannot be cleaned of mud to produce formation water because the aquifer yields insufficient water, small amounts of potable water may be injected to clean up this poorly yielding well. This may be done by dumping in buckets of water. When most of the mud is out, continue development

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with formation water only. It is essential that at least five times the amount of water injected must be produced back from the well in order to assure that all injected water is removed from the formation.

9. Note the final color, clarity and odor of the water.
10. Measure the final pH, temperature and specific conductance of the water and record in the site logbook.
11. Record the following data in the site logbook:
 - Well designation (location ID)
 - Date(s) of well installation
 - Date(s) and time of well development
 - Static water level before and after development
 - Quantity of water removed and time of removal
 - Type and size/capacity of pump and/or bailer used
 - Description of well development techniques used

7.3 Post-Operation

1. Decontaminate all equipment.
2. Store containers of water produced during development in a safe and secure area.
3. After the first round of analytical results have been received, determine and implement the appropriate water disposal method.

8.0 Calculations

There are no calculations necessary to implement this procedure. However, if it is necessary to calculate the volume of water in the well, utilize the following equation:

$$\text{Well volume} = \pi r^2 h (cf) \text{ (Equation 1)}$$

where:

π = pi
 r = radius of monitoring well (feet)
 h = height of the water column (feet)
(This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.)
 cf = conversion facto (gal/ft') = 7.48 gal/ft' (In this equation, 7.48 gal/ft is the necessary conversion factor.)

Monitor well diameters are typically 2", 3", 4", or 6". Knowing the diameter of the monitor well, there are a number of standard conversion factors which can be used to simplify the equation above.

The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follow:

$$V \text{ (gal/ft)} = \pi r^2 (cf) \text{ (Equation 2)}$$

where:

π = pi
 r = radius of monitoring well (feet)
 cf = conversion factor (7.48 gal/ft')

Remember that if you have a two inch diameter well you must convert this to the radius in feet to be able to use the equation.

The conversion factors for the common size monitor wells are as follows:

Well diameter	2"	3"	4"	6"
Volume(gal/ft)	0.1632	0.3672	0.6528	1.4688

If you utilize the conversion factors above, Equation 1 should be modified as follows:

$$\text{Well volume} = (h)(cf) \text{ (Equation 3)}$$

where:

h = height of water column (feet)
 cf = the conversion factor calculated from Equation 2

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9.0 Quality Assurance/Quality Control

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented in personal/site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

Part 2: Case Histories", Groundwater V25, No 4, 1987 pp. 427-439.

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10.0 Data Validation

This section is not applicable to this SOP.

11.0 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety practices.

12.0 References

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Sampling Equipment - Decontamination

Page 1

SOP # FW-S-007

REVISION DATE: November 18, 1998

1.0 Scope and Application

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) or Carlson Environmental, Inc. endorsement or recommendation for use.

2.0 Method Summary

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. This may be preceded by a steam or high pressure water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the

detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted.

Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern at a given site or if Target Compound List analysis (which includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry
9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine (9) step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

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Sampling Equipment - Decontamination

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3.0 Sample Preservation, Containers, Handling and Storage

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest.

More specifically, sample collection and analysis of decontamination waste may be required before beginning proper disposal of decontamination liquids and solids generated at a site. This should be determined prior to initiation of site activities.

4.0 Interferences and Potential Problems

- The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).
- The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.
- If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.
- Damage can be incurred by acid and solvent washing of complex and sophisticated sampling equipment.

5.0 Equipment/Apparatus

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, soft bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold wash and rinse solutions. Children's wading

pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment.

Contaminated liquid can be stored temporarily in metal or plastic cans or drums.

The following standard materials and equipment are recommended for decontamination activities:

5.1 Decontamination Solutions

- Non-phosphate detergent
- Selected solvents (acetone, hexane, nitric acid, etc.)
- Tap water
- Distilled or deionized water

5.2 Decontamination Tools/Supplies

- Long and short handled brushes
- Bottle brushes
- Drop cloth/plastic sheeting
- Paper towels
- Plastic or galvanized tubs or buckets
- Pressurized sprayers (H₂O)
- Solvent sprayers
- Aluminum foil

5.3 Health and Safety Equipment

Appropriate personal protective equipment (i.e., safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, emergency eye wash)

5.4 Waste Disposal

- Trash bags
- Trash containers
- 55-gallon drums
- Metal/plastic buckets/containers for storage and disposal of decontamination solutions

6.0 Reagents

There are no reagents used in this procedure aside from the actual decontamination solutions. In general, the following solvents are typically utilized

contaminants by neutralization, chemical reaction, for decontamination purposes:

- 10% nitric acid is typically used for Physical decontamination techniques can be grouped inorganic compounds such as metals. An into two categories: abrasive methods and acid rinse may not be required if inorganics non-abrasive methods, as follows: are not a contaminant of concern.
- Acetone (pesticide grade)⁽¹⁾
- Hexane (pesticide grade)⁽¹⁾
- Methanol ⁽¹⁾

⁽¹⁾-Only if sample is to be analyzed for organics.

7.0 Procedure

As part of the health and safety plan, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

- The number, location, and layout of decontamination stations.
- Decontamination equipment needed.
- Appropriate decontamination methods.
- Methods for disposal of contaminated clothing, equipment, and solutions.
- Procedures can be established to minimize the potential for contamination. This may include:
 - (1) work practices that minimize contact with potential contaminants;
 - (2) using remote sampling techniques;
 - (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material;
 - (4) watering down dusty areas;
 - (5) avoiding laying down equipment in areas of obvious contamination; and
 - (6) use of disposable sampling equipment.

7.1 Decontamination Methods

All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate contaminants by neutralization, chemical reaction, disinfection, or sterilization.

Physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods, as follows:

7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

Mechanical

Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.

Air Blasting

Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.

Wet Blasting

Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

Low-Pressure Water

This method consists of a container which is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.

High-Pressure Water

This method consists of a high-pressure pump, an operator controlled directional nozzle, and a high-pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.

Ultra-High-Pressure Water

This system produces a water jet that is pressured from 1,000 to 4,000 atmospheres. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.

Rinsing

Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

Damp Cloth Removal

In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization

Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

7.2 Field Sampling Equipment Decontamination Procedures

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of three (3) feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: Hot Zone or Exclusion Zone (EA.), the Contamination Reduction Zone (CRZ), and the Support or Safe Zone (SZ). The decontamination line should be setup in the Contamination Reduction Corridor (CRC) which is in the CRZ. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor depends on the number of stations in the

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Sampling Equipment - Decontamination

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decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

7.2.1 Decontamination Setup

Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1: Segregate Equipment Drop

Place plastic sheeting on the ground. Size will depend on amount of equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment which is likely to be heavily contaminated.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

As indicated in 7.1.2, a high-pressure wash may be required for compounds which are difficult to remove by washing with brushes. The elevated temperature of the water from the high-pressure washers is excellent at removing greasy/oily compounds. High pressure washers require water and electricity.

Station 3: Physical Removal With Brushes And A Wash Basin

Prior to setting up Station 3, place plastic sheeting on the ground to cover areas under Station 3 through Station 10.

Fill a wash basin, a large bucket, or child's swimming pool with non-phosphate detergent and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station.

Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross

Station 4: Water Basin

Fill a wash basin, a large bucket, or child's swimming pool with tap water. Several bottle and bristle brushes should be dedicated to this station. Approximately 10-50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 5: Low-Pressure Sprayers

Fill a low pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the water during the rinsing process. Approximately 10-20 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 6: Nitric Acid Sprayers

A decontamination pad may be required for the high- Fill a spray bottle with 10% nitric acid. An acid rinse may not be required if inorganics are not a contaminant of concern. The amount of acid will depend on the amount of equipment to be decontaminated. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 7: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

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Station 8: Organic Solvent Sprayers

Fill a spray bottle with an organic solvent. After each solvent, the equipment should be rinsed with distilled/deionized water and air dried. Amount of solvent will depend on the amount of equipment to decontaminate. Provide a 5-gallon bucket or basin to collect the solvent during the rinsing process.

Solvent rinses may not be required unless organics are a contaminant of concern, and may be eliminated from the station sequence.

Station 9: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 10: Clean Equipment Drop

Lay a clean piece of plastic sheeting over the bottom plastic layer. This will allow easy removal of the plastic in the event that it becomes dirty. Provide aluminum foil, plastic, or other protective material to wrap clean equipment.

7.2.2 Decontamination Procedures

Station 1: Segregate Equipment Drop

Deposit equipment used on-site (i.e., tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic zip lock bags if contamination is evident.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

Use high pressure wash on grossly contaminated equipment. Do not use high-pressure wash on sensitive or non-waterproof equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) which is waterproof should be washed. Equipment which is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

Station 4: Equipment Rinse

Wash soap off of equipment with water by immersing the equipment in the water while brushing. Repeat as many times as necessary.

Station 5: Low-Pressure Rinse

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 6: Nitric Acid Sprayers (required only if metals are a contaminant of concern)

Using a spray bottle rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station. Refer to Section 9.

Station 7: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

Station 8: Organic Solvent Sprayers

Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

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Sampling Equipment - Decontamination

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Station 9: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

Station 10 : Clean Equipment Drop

Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

7.2.3 Post Decontamination Procedures

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum of container. A sump pump can aid in the collection process. Refer to the Department of Transportation (DOT) requirements for appropriate containers based on the contaminant of concern.
2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.
3. Empty soap and water liquid wastes from basins and buckets and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.
4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.
5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.

6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.
7. Empty low-pressure sprayer water onto the ground.
8. Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.
9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated from the decontamination process.

8.0 Calculations

This section is not applicable to this SOP

9.0 Quality Assurance/Quality Control

A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field.

Rinsate blanks are samples obtained by running analyte free water over decontaminated sampling equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day. A rinsate blank is used to assess cross contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day per type of sampling device samples to meet QA2 and QA3 objectives.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and

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Sampling Equipment - Decontamination

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replaced with clean tubing before additional sampling occurs.

10.0 Data Validation

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

11.0 Health and Safety

When working with potentially hazardous materials, follow OSHA, U.S. EPA, corporate, and other applicable health and safety procedures.

Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitution should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination equipment. Maximum air pressure produce by abrasive equipment could cause physical injury. Displaced material requires control mechanisms.

Material generated from decontamination activities requires proper handling, storage, and disposal. Personal Protective Equipment may be required for these activities.

Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone, alcohol, and trisodiumphosphate).

In some jurisdictions, phosphate containing detergents (i.e., TSP) are banned.

12.0 References -U.S. EPA Environmental Response Team, SOP #2006 Rev. 0-0, October 3,1994.

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

A Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, April 1, 1986.

Guidelines for the Selection of Chemical Protective Clothing, Volume 1, Third Edition, American Conference of Governmental Industrial Hygienists, Inc., February, 1987.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October, 1985.

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SOP # FW-C-004

REVISION DATE: October 20, 1998

1.0 Scope and Application

This standard operating procedure (SOP) is applicable to the collection of representative sediment samples. Analysis of sediment may be biological, chemical, or physical in nature and may be used to determine the following:

- toxicity;
- biological availability and effects of contaminants; benthic biota;
- extent and magnitude of contamination;
- contaminant migration pathways and source;
- fate of contaminants;
- grain size distribution.

The methodologies discussed in this SOP are applicable to the sampling of sediment in both flowing and standing water. They are generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by site conditions and equipment limitations. However, if modifications occur, they should be documented in a site or personal logbook and discussed in reports summarizing field activities and analytical results.

For the purposes of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer. The aqueous layer may be either static, as in lakes, ponds, and impoundments; or flowing, as in rivers and streams.

Mention of trade names or commercial products does not constitute U.S. EPA or Carlson Environmental, Inc. (CEI) endorsement or recommendation for use.

2.0 Method Summary

Sediment samples may be collected using a variety of methods and equipment, depending on the depth of the aqueous layer, the portion of the sediment profile required (surface vs. subsurface), the type of

sample required (disturbed vs. undisturbed), contaminants present, and sediment type.

Sediment is collected from beneath an aqueous layer either directly, using a hand held device such as a shovel, trowel, or auger; or indirectly, using a remotely activated device such as an Ekman or Ponar dredge. Following collection, sediment is transferred from the sampling device to a sample container of appropriate size and construction for the analyses requested. If composite sampling techniques are employed, multiple grabs are placed into a container constructed of inert material, homogenized, and transferred to sample containers appropriate for the analyses requested. The homogenization procedure should not be used if sample analysis includes volatile organics; in this case, sediment, or multiple grabs of sediment, should be transferred directly from the sample collection device or homogenization container to the sample container.

3.0 Sample Preservation, Containers, Handling and Storage

1. Chemical preservation of solids is generally not recommended. Cooling to 4° C is usually the best approach, supplemented by the appropriate holding time for the analyses requested.
2. Wide mouth glass containers with Teflon lined caps are utilized for sediment samples. The sample volume is a function of the analytical requirements and will be specified in the Work Plan.
3. If analysis of sediment from a discrete depth or location is desired, sediment is transferred directly from the sampling device to a labeled sample container(s) of appropriate size and construction for the analyses requested. Transfer is accomplished stainless steel or plastic lab spoon or equivalent.
4. If composite sampling techniques or multiple grabs are employed, equal portions of sediment from each location are deposited into a stainless steel, plastic, or other appropriate composition

(e.g., Teflon) containers. The sediment is homogenized thoroughly to obtain a composite representative of the area sampled. The composite sediment sample is transferred to a labeled container(s) of appropriate size and construction for the analyses requested. Transfer of sediment is accomplished with a stainless steel or plastic lab spoon or equivalent. Samples for volatile organic analysis must be transferred directly from the sample collection device or pooled from multiple areas in the homogenization container prior to mixing. This is done to minimize loss of contaminant due to volatilization during homogenization.

5. All sampling devices should be decontaminated, then wrapped in aluminum foil. The sampling device should remain in this wrapping until it is needed. Each sampling device should be used for only one sample. Disposable sampling devices for sediment are generally impractical due to cost and the large number of sediment samples which may be required. Sampling devices should be cleaned in the field using the decontamination procedure described in the Sampling Equipment Decontamination SOP # FW-S-007.

4.0 Interferences and Potential Problems

Substrate particle size and organic matter content are a direct consequence of the flow characteristics of a water body. Contaminants are more likely to be concentrated in sediments typified by fine particle size and a high organic matter content. This type of the sediment is most likely to be collected from depositional zones. In contrast, coarse sediments with low organic matter content do not typically concentrate pollutants and are generally found in erosional zones. The selection of a sampling location can, therefore, greatly influence the analytical results and should be justified and specified in the Work Plan.

5.0 Equipment/Apparatus

Equipment needed for collection of sediment samples may include:

- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Stainless steel, plastic, or other appropriate composition bucket
- 4-oz., 8-oz., and one-quart wide mouth jars w/Teflon lined lids
- Ziploc plastic bags
- Logbook
- Sample jar labels
- Chain of Custody records, field data sheets
- Cooler(s)
- Ice
- Decontamination supplies/equipment
- Spade or shovel
- Spatula
- Scoop
- Trowel
- Bucket auger
- Tube auger
- Extension rods
- "T" handle
- Sediment coring device (tube, drive head, eggshell check valve, nosecone, acetate tube, extension rods, "T" handle)
- Ponar dredge
- Ekman dredge
- Nylon rope or steel cable
- Messenger device

6.0 Reagents

Reagents are not used for preservation of sediment samples. Decontamination solutions are specified in the Sampling Equipment Decontamination SOP # FW-S-007.

7.0 PROCEDURES

7.1 Preparation

1. Determine the objective(s) and extent of the sampling effort. The sampling methods to be employed, and the types and amounts of

equipment and supplies required will be a function of site characteristics and objectives of the study.

2. Obtain the necessary sampling and monitoring equipment.
3. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.
4. Decontaminate or preclean equipment, and ensure that it is in working order.
5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.
6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors including flow regime, basin morphometry, sediment characteristics, depth of overlying aqueous layer, contaminant source, and extent and nature of contamination should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Sample Collection

Selection of a sampling device is most often contingent upon: (1) the depth of water at the sampling location, and (2) the physical characteristics sediment to be sampled. The following procedures may be utilized:

7.2.1 Sampling Surface Sediment with a Trowel or Scoop from Beneath a Shallow Aqueous Layer

For the purpose of this method, surface sediment is considered to range from 0 to six inches in depth and a shallow aqueous layer is considered to range from 0 to 12 inches in depth. Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with tools such as spades, shovels, trowels, and scoops. Although this method can be used to collect both unconsolidated/consolidated sediment, it is limited somewhat by the depth and movement of the aqueous layer. Deep and rapidly flowing water render this method less accurate than

others discussed below. However, representative samples can be collected with this procedure in shallow sluggish water provided care is demonstrated by the sample team member. A stainless steel or plastic sampling implement will suffice in most applications. Care should be exercised to avoid the use of devices plated with chrome or other materials; plating is particularly common with garden trowels.

The following procedure will be used to collect sediment with a scoop, shovel, or trowel:

1. Using a decontaminated sampling implement, remove the desired thickness and volume of sediment from the sampling area.
2. Transfer the sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.
3. Surface water should be decanted from the sample or homogenization container prior to sealing or transfer; care should be taken to retain the fine sediment fraction during this procedure.

7.2.2 Sampling Surface Sediment with a Bucket Auger or Tube Auger from Beneath a Shallow Aqueous Layer

For the purpose of this method, surface sediment is considered to range from 0 to six inches in depth and a shallow aqueous layer is considered to range from 0 to 24 inches in depth. Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of bucket auger or tube auger, a series of extensions, and a "T" handle. The use of additional extensions in conjunction with a bucket auger can increase the depth of water from which sediment can be collected from 24 inches to 10 feet or more. However, sample handling and manipulation increases in difficulty with increasing depth of water. The bucket auger or tube auger is driven into the sediment and used to extract a core. The various depths represented by the core are homogenized or a

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subsample of the core is taken from the appropriate depth.

The following procedure will be used to collect sediment samples with a bucket auger or tube auger:

1. An acetate core may be inserted into the bucket auger or tube auger prior to sampling if characteristics of the sediments or water body warrant. By using this technique, an intact core can be extracted.
2. Attach the auger head to the required length of extensions, then attach the "T" handle to the upper extension.
3. Clear the area to be sampled of any surface debris.
4. Insert the bucket auger or tube auger into the sediment at a 0° to 20° angle from vertical. This orientation minimizes spillage of the sample from the sampler upon extraction from the sediment and water.
5. Rotate the auger to cut a core of sediment.
6. Slowly withdraw the auger; if using a tube auger, make sure that the slot is facing upward.
7. Transfer the sample or a specified aliquot of sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.

7.2.3 Sampling Deep Sediment with a Bucket Auger or Tube Auger from Beneath a Shallow Aqueous Layer

For the purpose of this method, deep sediment is considered to range from six to greater than 18 inches in depth and a shallow aqueous layer is considered to range from 0 to 24 inches. Collection of deep sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of a bucket auger, a tube auger, a series of extensions and a "T" handle. The use of additional

extensions can increase the depth of water from which sediment can be collected from 24 inches to five feet or more. However, water clarity must be high enough to permit the sampler to directly observe the sampling operation. In addition, sample handling and manipulation increases in difficulty with increasing depth of water. The bucket auger is used to bore a hole to the upper range of the desired sampling depth and then withdrawn. The tube auger is then lowered down the borehole, and driven into the sediment to the lower range of the desired sampling depth. The tube is then withdrawn and the sample recovered from the tube. This method can be used to collect firmly consolidated sediments, But is somewhat limited by the depth of the aqueous layer, and the integrity of the initial borehole.

The following procedure will be used to collect deep sediment samples with a bucket auger and a tube auger:

1. Attach the bucket auger bit to the required lengths of extensions, then attach the "T" handle to the upper extension.
2. Clear the area to be sampled of any surface debris.
3. Begin auguring, periodically removing any accumulated sediment (i.e., cuttings) from the auger bucket. Cuttings should be disposed of far enough from the sampling area to minimize cross contamination of various depths.
4. After reaching the upper range of the desired depth, slowly and carefully remove bucket auger from the boring.
5. Attach the tube auger bit to the required lengths of extensions, then attach the "T" handle to the upper extension.
6. Carefully lower tube auger down borehole using care to avoid making contact with the borehole sides and, thus, cross contaminating the sample. Gradually force tube auger into sediment to the lower range of the desired sampling depth. Hammering of the tube auger to facilitate coring

should be avoided as the vibrations may cause the boring walls to collapse.

7. Remove tube auger from the borehole, again taking care to avoid making contact with the borehole sides and, thus, cross contaminating the sample.
8. Discard the top of core (approximately 1 inch); as this represents material collected by the tube auger before penetration to the layer concern.
9. Transfer sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.

7.2.4 Sampling Surface Sediment with an Ekman or Ponar Dredge from Beneath a Shallow or Deep Aqueous Layer

For the purpose of this method, surface sediment is considered to range from 0 to six inches in depth. Collection of surface sediment can be accomplished with a system consisting of a remotely activated device (dredge) and a deployment system. This technique consists of lowering a sampling device (dredge) to the surface of the sediment by use of a rope, cable, or extended handle. The mechanism is activated, and the device entraps sediment in spring loaded or lever operated jaws.

An Ekman dredge is a lightweight sediment sampling device with spring activated jaws. It is used to collect moderately consolidated, fine textured sediment. The following procedure will be used for collecting sediment with an Ekman dredge

1. Attach a sturdy nylon rope or stainless steel cable through the hole on the top of the bracket, or secure the extension handle to the bracket with machine bolts.
2. Attach springs to both sides of the jaws. Fix the jaws so that they are in open position by placing trip cables over the release studs. Ensure that the hinged doors on the dredge top are free to open.

3. Lower the sampler to a point 4 to 6 inches above the sediment surface.

4. Drop the sampler to the sediment.

5. Trigger the jaw release mechanism by lowering a messenger down the line, or by depressing the button on the upper end of the extension handle.

6. Raise the sampler and slowly decant any free liquid through the top of the sampler. Care should be taken to retain the fine sediment fraction during this procedure.

7. Open the dredge jaws and transfer the sample into a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment grabs until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

A Ponar dredge is a heavyweight sediment sampling device with weighted jaws that are lever or spring activated. It is used to collect consolidated fine to coarse textured sediment. The following procedure will be used for collecting sediment with a Ponar dredge

1. Attach a sturdy nylon rope or steel cable to the ring provided on top of the dredge.
2. Arrange the Ponar dredge with the jaws in the open position, setting the trip bar so the sampler remains open when lifted from the top. If the dredge is so equipped, place the spring loaded pin into the aligned holes in the trip bar.
3. Slowly lower the sampler to a point approximately two inches above the sediment.

4. Drop the sampler to the sediment. Slack on the line will release the trip bar or spring loaded pin; pull up sharply on the line
5. Raise the dredge to the surface and slowly decant any free liquid through the screens on top of the dredge. Care should be taken to retain the fine sediment fraction during this operation.
6. Open the dredge and transfer the sediment to a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill requirements. Thoroughly homogenized and then transfer sediment for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.
1. Assemble the coring device by inserting the acetate core into the sampling tube.
2. Insert the "egg shell" check valve into the lower end of the sampling tube with the convex surface positioned inside the acetate core.
3. Screw the nosecone onto the lower end of the sampling tube, securing the acetate tube and eggshell check valve.
4. Screw the handle onto the upper end of the sampling tube and add extension rods as needed.
5. Place the sampler in a perpendicular position on the sediment to be sampled.
6. If the "T" handle is used, place downward pressure on the device until the desired depth is reached. After the desired depth is reached, rotate the sampler to shear off the core at the bottom. Slowly withdraw the sampler from the sediment and proceed to step 15.

7.2.5 Sampling Subsurface Sediment with a Coring Device from Beneath a Shallow Aqueous Layer

For purposes of this method, subsurface sediment is considered to range from 6 to 24 inches in depth and a shallow aqueous layer is considered to range from 0 to 24 inches in depth. Collection of subsurface sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of a tube sampler, acetate tube, eggshell check valve, nosecone, extensions, and "T" handle, or drivehead. The use of additional extensions can increase the depth of water from which sediment can be collected from 24 inches to 10 feet or more. This sampler may be used with either a drive hammer for firm sediment, or a "T" handle for soft sediment. However, sample handling and manipulation increases in difficulty with increasing depth of water.

The following procedure describes the use of a sample coring device used to collect subsurface sediments.

7. If the drive hammer is selected, insert the tapered handle (drive head) of the drive hammer through the drive head.
8. Drive the sampler into the sediment to the desired depth.
9. Record the length of the tube that penetrated the sample material, and the number of blows required to obtain this depth.
10. Remove the drive hammer and fit the keyhole-like opening on the flat side of the hammer onto the drive head. In this position, the hammer serves as a handle for the sampler.
11. Rotate the sampler to shear off the core at the bottom.
12. Lower the sampler handle (hammer) until it just clears the two ear-like protrusions on the drive head, and rotate about 90°.

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13. Slowly withdraw the sampler from the sediment. If the drivehead was used, pull the hammer upwards and dislodge the sampler from the sediment.
14. Carefully remove the coring device from the water.
15. Unscrew the nosecone and remove eggshell check valve.
16. Slide the acetate core out of the sampler tube. Decant surface water, using care to retain the fine sediment fraction. If head space is present in the upper end, a hacksaw may be used to shear the acetate tube off at the sediment surface. The acetate core may then be capped at both ends. Indicate on the acetate tube the appropriate orientation of the sediment core using a waterproof marker. The sample may be used in this fashion, or the contents transferred to a sample or homogenization container.
17. Open the acetate tube and transfer the sediment to a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

8.0 Calculations

This section is not applicable to this SOP.

9.0 Quality Assurance/Quality Control

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 Data Validation

This section is not applicable to this SOP.

11.0 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA/OSHA and Corporate health and safety procedures.

More specifically, when sampling sediment from water bodies, physical hazards must be identified and adequate precautions must be taken to ensure the safety of the sampling team. The team member collecting the sample should not get too close to the edge of the water body, where bank failure may cause loss of balance. To prevent this, the person performing the sampling should be on a lifeline, and be wearing adequate protective equipment. If sampling from a vessel is determined to be necessary, appropriate protective measures must be implemented.

12.0 References -USEPA Environmental Response Team, SOP #2016 Rev. 0-0, October 3, 1994.

Mason, B.J., Preparation of Soil Sampling Protocol: Technique and Strategies. 1983 EPA-600/4-83-020.

Barth, D.S. and B.J. Mason, Soil Sampling Quality Assurance User's Guide. 1984 EPA-600/4-84-043.

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Ground Water Sampling - General

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SOP # FEW-C-006

REVISION DATE: October 20, 1998

1.0 Scope and Application

The objective of this standard operating procedure (SOP) is to provide general reference information on sampling of ground water wells. This guideline is primarily concerned with the collection of water samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. These procedures are designed to be used in conjunction with analyses for the most common types of ground water contaminants (e.g., volatile and semi-volatile organic compounds, pesticides, metals, biological parameters).

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) or Carlson Environmental, Inc. (CEI) endorsement or recommendation for use.

2.0 Method Summary

In order to obtain a representative groundwater sample for chemical analysis it is important to remove stagnant water in the well casing and the water immediately adjacent to the well before collection of the sample. This may be achieved with one of a number of instruments. The most common of these are the bailer, submersible pump, non-contact gas bladder pump, inertia pump and suction pump. At a minimum, three well volumes should be purged, if possible. Equipment must be decontaminated prior to use and between wells.

Once purging is completed and the correct laboratory-cleaned sample containers have been prepared, sampling may proceed. Sampling may be conducted with any of the above instruments, and need not be the same as the device used for purging.

Care should be taken when choosing the sampling device as some will affect the integrity of the sample. Sampling should occur in a progression from the least to most contaminated well, if this information is known.

The growing concern over the past several years over low levels of volatile organic compounds in water supplies has led to the development of highly sophisticated analytical methods that can provide detection limits at part per trillion levels. While the laboratory methods are extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed and quality assured as the analytical procedures.

3.0 Sample Preservation, Containers, Handling and Storage

The type of analysis for which a sample is being collected determines the type of bottle, preservative, holding time, and filtering requirements. Samples should be collected directly from the sampling device into appropriate laboratory cleaned containers. Check that a Teflon liner is present in the cap, if required. Attach a sample identification label. Complete a field data sheet, a chain of custody form, and record all pertinent data in the site logbook.

Samples shall be appropriately preserved, labeled, logged, and placed in a cooler to be maintained 4 °C. Samples must be shipped well before the holding time is up and ideally should be shipped within 24 hours of sample collection. It is imperative that samples be shipped or delivered daily to the analytical laboratory in order to maximize the time available for the laboratory to perform the analyses. The bottles should be shipped with adequate packing and cooling to ensure that they arrive intact.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions

and other constraints will limit the choice of appropriate systems. The focus of concern must remain to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

Treatment of the sample with sodium thiosulfate preservative is required only if there is residual chlorine in the water that could cause free radical chlorination and change the identity of the original contaminants. It should not be used if there is no chlorine in the water.

Holding time for volatiles analysis is seven days. It is imperative that the sample be shipped or delivered daily to the analytical laboratory. The bottles must be shipped on their sides to aid in maintaining the airtight seal during shipment, with adequate packing and cooling to ensure that they arrive intact.

For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies; field kit for chlorine, preservatives, Parafilm, foam sleeves and coolers. Due to the extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 General

The primary goal in performing ground water sampling is to obtain a representative sample of the ground water body. Analysis can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilizing trained field personnel.

4.2 Purging

In a nonpumping well, there will be little or no vertical mixing of the water, and stratification will occur. The well water in the screened section will mix with the ground water due to normal flow patterns, but the well water above the screened section will remain isolated, become stagnant, and may lack the contaminants representative of the ground water. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, resulting in an unrepresentative sample. To safeguard against collecting nonrepresentative stagnant water, the following guidelines and techniques should be adhered to during sampling:

1. As a general rule, all monitor wells should be pumped or bailed prior to sampling. Purge water should be containerized on site or handled as specified in the site specific project plan. Evacuation of a minimum of one volume of water in the well casing, and preferably three to five volumes, is recommended for a representative sample. In a high-yielding ground water formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample withdrawal is not as critical. However, in all cases where the monitoring data is to be used for enforcement actions, evacuation is recommended.
2. When purging with a pump (not a bailer), the pump should be set at the screened interval, or if the well is an open-rock well, it should be set at the same depth the sample will be collected. When sampling a screened well, the sample should also be collected from the same depth the pump was set at.
3. The well should be sampled as soon as possible after purging.
4. Analytical parameters typically dictate whether the sample should be collected through the purging device, or through a separate sampling instrument.

5. For wells that can be pumped or bailed to dryness with the equipment being used, the well should be evacuated and allowed to recover prior to collecting a sample. If the Advantages recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred. If recovery is slow, sample the well upon recovery after one evacuation.

6. A non-representative sample can also result from excessive pre-pumping of the monitoring well. Stratification of the leachate concentration in the ground water formation may occur, or heavier-than-water compounds may sink to the lower portions of aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point interest.

4.3 Materials

Materials of construction for samplers and evacuation equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon, and glass in areas where concentrations are expected to be at or near the detection limit. The tendency of organics to leach into and out of many materials make the selection of materials critical for trace analyses. The use of plastics, such as PVC or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation equipment as it will not come in contact with the sample, and in highly contaminated wells, disposable equipment (i.e., polypropylene bailers) may be appropriate to avoid cross-contamination.

Materials of construction (bladders/ pumps, bailers, tubing, etc.) suitable for collecting and handling Volatile Organic Samples should be limited to stainless steel, Teflon and glass in areas which detection limit range concentrations are expected. The tendency of organics to leach into and out of many materials, make the selection of materials critical for these trace analyses. The use of plastics, e.g., PVC etc., should be avoided. There are numerous ways of introducing foreign contaminants wells into a sample, and these must be avoided by

following strict sampling procedures and utilization of trained personnel.

4.4 Advantages/Disadvantages of Certain Equipment

4.4.1 Bailers

Advantages

- Portable
- Only practical limitations on size and material
- No power source needed
- Readily available
- Removes stagnant water first
- Rapid, simple method for removing small volumes of purge water
- Minimal outgassing of volatile organics while sample is in bailer

Disadvantages

- Time-consuming to flush a large well of stagnant water
- Transfer of sample may cause aeration
- Stoppers at the bottom of the bailer usually leak thus the bailer must be brought to the surface rapidly
- If the bailer is allowed to hit the bottom of the well boring, gravel can displace the ball valve not allowing the bailer to hold water

4.4.2 Submersible Pumps

Advantages

- Portable and can be transported to several wells
- Depending upon the size of the pump and the pumping depths, relatively high rates are possible
- Generally very reliable and does not require priming

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Disadvantages

- Potential for effects on analysis of trace organics Heavy and cumbersome to deal with, particularly in deeper wells
- Expensive
- Power source needed
- Sediment in water may cause problems with the pumps
- Impractical in low yielding or shallow wells

4.4.3 Non-Contact Gas Bladder Pumps

Advantages

- Maintains integrity of sample
- Easy to use
- Can sample from discrete locations within the monitor well

Disadvantages

- Difficulty in cleaning, though dedicated diameter wells tubing and bladder may be used Only useful to about 100 feet
- Supply of gas for operation, gas bottles and/or compressors are often difficult to obtain and are cumbersome
- Relatively low pumping rates
- Requires air compressor or pressurized gas source and control box

4.4.4 Suction Pumps

Advantages

- Portable, inexpensive, and readily available

Disadvantages

- Restricted to areas with water levels within 20 to 25 feet of the ground surface
- Vacuum can cause loss of dissolved gasses and volatile organics

- Pump must be primed and vacuum is often difficult to maintain during initial stages of pumping.

4.4.5 Inertia Pumps

Advantages

- Portable, inexpensive, and readily available
- Offers a rapid method for purging relatively shallow wells

Disadvantages

- May be time consuming to purge wells with these manual pumps
- Labor intensive
- WaTerra pumps are only effective in 2-inch diameter wells

5.0 EQUIPMENT APPARATUS

5.1 Equipment Checklist

5.1.1 General

- Water level indicator
 - electric sounder
 - steel tape
 - transducer
 - reflection sounder
 - airline
- Depth sounder
- Appropriate keys for well cap locks
- Steel brush
- HNU or OVA (whichever is most appropriate)
- Logbook
- Calculator
- Field data sheets and samples labels
- Chain of custody records and seals
- Sample containers
- Engineer's rule
- Sharp knife (locking blade)

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- Tool box (to include at least: screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench)
- Leather work gloves
- Appropriate Health & Safety gear
- 5-gallon pail
- Plastic sheeting
- Shipping containers
- Packing materials
- Bolt cutters
- Ziploc plastic bags
- Containers for evacuation liquids
- Decontamination solutions
- Tap water
- Non phosphate soap
- Several brushes
- Pails or tubs
- Aluminum foil
- Garden sprayer
- Preservatives
- Distilled or deionized water
- Fire extinguisher (if using a generator for your power source)

5.1.2 Bailers

- Clean, decontaminated bailers of appropriate size and construction material
- Nylon line, enough to dedicate to each well
- Teflon coated bailer wire
- Sharp knife
- Aluminum foil (to wrap clean bailers)
- Five gallon bucket

5.1.3 Submersible Pump

- Pump(s)
- Generator (110, 120, or 240 volt) or 12 volt battery if inaccessible to field vehicle - amp meter is useful
- 1" black PVC coil tubing - enough to dedicate to each well
- Hose clamps
- Safety cable
- Tool box supplement
 - pipe wrenches
 - wire strippers

- electrical tape
- heat shrink
- hose connectors
- Teflon tape

5.1.4 Non-Gas Contact Bladder Pump

- Non-gas contact bladder pump
- Compressor or nitrogen gas tank
- Batteries and charger
- Teflon tubing - enough to dedicate to each well
- Swagelock fitting
- Toolbox supplements - same as submersible pump
- Control box (if necessary)

5.1.5 Suction Pump

- Pump
- 1" black PVC coil tubing - enough to dedicate to each well
- Gasoline - if required
- Toolbox
- Plumbing fittings
- Flow meter with gate valve

5.1.6 Inertia Pump

- Pump assembly (WaTerra pump, piston pump)
- Five gallon bucket

6.0 Reagents

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in SOP #FW-S-007, Sampling Equipment Decontamination.

7.0 PROCEDURE

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types

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and amounts of equipment and supplies needed (i.e., diameter and depth of wells to be sampled).

2. Obtain necessary sampling and monitoring equipment, appropriate to type of contaminant being investigated. For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies; field kit for chlorine, preservatives, Parafilm, foam sleeves and coolers. Due to extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.

3. Decontaminate or preclean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.
6. Identify and mark all sampling locations.

7.2 Field Preparation

1. Start at the least contaminated well, if known.
2. Lay plastic sheeting around the well to minimize likelihood of contamination of equipment from soil adjacent to the well.
3. Remove locking well cap, note location, time of day, and date in field notebook or appropriate log form.
4. Remove well casing cap.
5. Screen headspace of well with an appropriate monitoring instrument to determine the presence of volatile organic compounds and record in site logbook.

6. Lower water level measuring device or equivalent (i.e., permanently installed transducers or airline) into well until water surface is encountered.
7. Measure distance from water surface to reference measuring point on well casing or protective barrier post and record in site logbook. Alternatively, if no reference point, note that water level measurement is from top of steel casing, top of PVC riser pipe, from ground surface, or some other position on the well head.

If floating organics are of concern, this can be determined by measuring the water level with an oil/water interface probe which measures floating organics.

8. Measure total depth of well (at least twice to confirm measurement) and record in site logbook or on field data sheet.
9. Calculate the volume of water in the well and the volume to be purged using the calculations in Section 8.0.
10. Select the appropriate purging and sampling equipment.
11. If residual chlorine is suspected, use the Hach Field Test Kit for chlorine to determine if there is residual chlorine in the water to be sampled. If there is, treat the sample vial with a crystal of sodium thiosulfate prior to sample collection.

7.3 Purging

The amount of flushing a well receives prior to sample collection depends on the intent of the monitoring program as well as the hydrogeologic conditions. Programs where overall quality determination of water resources are involved may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume can be determined prior to sampling so that the sample is collected after a known volume of the water is evacuated from the aquifer, or the well can be pumped until the

stabilization of parameters such as temperature, electrical conductance, pH, or turbidity until the bailer is completely submerged, has occurred.

However, monitoring for defining a contaminant plume requires a representative sample of a small volume of the aquifer. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce flow from other areas. Generally, three well volumes are considered effective, or calculations can be made to determine, on the basis of the aquifer parameters and well dimensions, the appropriate volume to remove prior to sampling.

During purging, water level measurements may be taken regularly at 15-30 second intervals. This data may be used to compute aquifer transmissivity and other hydraulic characteristics. The following well evacuation devices are most commonly used. Other evacuation devices are available, but have been omitted in this discussion due to their limited use.

7.3.1 Bailers

Bailers are the simplest purging device used and have many advantages. They generally consist of a rigid length of tube, usually with a ball check-valve at the bottom. A line is used to lower the bailer into the well and retrieve a volume of water. The three most common types of bailer are PVC, Teflon, and stainless steel.

This manual method of purging is best suited to shallow or narrow diameter wells. For deep, larger diameter wells which require evacuation of large extremely volumes of water, other mechanical devices may be more appropriate.

7.3.1.1 Operation

Equipment needed will include a clean decontaminated bailer, Teflon or nylon line, a sharp knife, and plastic sheeting.

1. Determine the volume of water to be purged as described in 8.0, calculations.

2. Lay plastic sheeting around the well to prevent contamination of the bailer line foreign materials.
3. Attach the line to the bailer and slowly lower until the bailer is completely submerged, being careful not to drop the bailer to the water, causing turbulence and the possible loss of volatile organic contaminants.
4. Pull bailer out ensuring that the line either falls onto a clean area of plastic sheeting or never touches the ground.
5. Empty the bailer into a pail until full to determine the number of bails necessary to achieve the required purge volume.
6. Thereafter, pour the water into a container and dispose of purge waters as specified in the site specific sampling plan.

7.3.2 Submersible Pumps

The use of submersible pumps for sample collection is permissible provided they are constructed of suitably noncontaminating materials. The chief drawback, however, is the difficulty avoiding cross-contamination between wells. Although some units can be disassembled easily to allow surfaces contacted by contaminants to be cleaned, field decontamination may be difficult and require solvents that can affect sample analysis. The use of submersible pumps in multiple well-sampling programs, therefore, should be carefully considered against other sampling mechanisms (bailers, bladder pumps). In most cases, a sample can be collected by bailer after purging with a submersible pump, however, submersible pumps may be the only practical sampling device for extremely deep wells (greater than 300 feet of water). Under those conditions, dedicated pump systems should be installed to eliminate the potential for cross contamination of well samples.

Submersible pumps generally use one of two types of power supplies, either electric or compressed gas or air. Electric powered pumps can run off a 12 volt

DC rechargeable battery, or a 110 or 220 volt AC power supply. Those units powered by compressed air normally use a small electric or gas-powered air compressor. They may also utilize compressed gas (i.e., nitrogen) from bottles. Different size pumps are available for different depth or diameter monitoring wells.

7.3.2.1 Operation

1. Determine the volume of water to be purged as described in 8.0 Calculations.
2. Lay plastic sheeting around the well to prevent contamination of pumps, hoses or lines with foreign materials.
3. Assemble pump, hoses and safety cable, and lower the pump into the well. Make sure the pump is deep enough so all the water is not evacuated. (Running the pump without water cause damage.)
4. Attach flow meter to the outlet hose to well to measure the volume of water purged.
5. Use a ground fault circuit interrupter (GFCI) or ground the generator to avoid possible electric shock.
6. Attach power supply, and purge the well until the specified volume of water has been evacuated (or until field parameters, such as temperature, pH, conductivity, etc, have stabilized). Do not allow the pump to run dry. If the pumping rate exceeds the well recharge rate, lower the pump further into the well, and continue pumping.
7. Collect and dispose of purge waters as specified in the site specific sampling plan.

7.3.3 Non-Contact Gas Bladder Pumps

For this procedure, an all stainless-steel and Teflon Middleburg-squeeze bladder pump (e.g., IEA, TIMCO, Well Wizard, Geoguard, and others) is used to provide the least amount of material

interference to the sample (Barcelona, 1985). Water comes into contact with the inside of the bladder (Teflon) and the sample tubing, also Teflon, that may be dedicated to each well. Some wells may have permanently installed bladder pumps, (i.e., Well Wizard, Geoguard), that will be used to sample for all parameters.

7.3.3.1 Operation

1. Assemble Teflon tubing, pump and charged control box.
2. Procedure for purging with a bladder pump is the same as for a submersible pump (Section 7.3.2.1).
3. Be sure to adjust flow rate to prevent violent jolting of the hose as sample is drawn in.

7.3.4 Suction Pumps

There are many different types of suction pumps. They include: centrifugal, peristaltic and diaphragm. Diaphragm pumps can be used for well evacuation at a fast pumping rate and sampling at a low pumping rate. The peristaltic pump is a low volume pump that uses rollers to squeeze the flexible tubing thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination. Peristaltic pumps, however, require a power source.

7.3.4.1 Operation

1. Assembly of the pump, tubing, and power source if necessary.
2. Procedure for purging with a suction pump is exactly the same as for a submersible pump (Section 7.3.2.1).

7.3.5 Inertia Pumps

Inertia pumps such as the WaTerra pump and piston pump, are manually operated. They are most appropriate to use when wells are too deep to bail by hand, or too shallow or narrow (or inaccessible) to warrant an automatic (submersible, etc.) pump.

These pumps are made of plastic and may be either decontaminated or discarded.

7.3.5.1 Operation

1. Determine the volume of water to be purged as described in 8.0, Calculations.
2. Lay plastic sheeting around the well to prevent contamination of pumps or hoses with foreign materials.
3. Assemble pump and lower to the appropriate depth in the well.
4. Begin pumping manually, discharging water into a 5 gallon bucket (or other graduated vessel). Purge until specified volume of water has been evacuated (or until field parameters such as temperature, pH, conductivity, etc. have stabilized).
5. Collect and dispose of purge waters as specified in the site specific project plan.

7.4 Sampling

Sample withdrawal methods require the use of pumps, compressed air, bailers, and samplers. Ideally, purging and sample withdrawal equipment should be completely inert, economical to manufacture, easily cleaned, sterilized, reusable, able to operate at remote sites in the absence of power resources, and capable of delivering variable rates for sample collection.

There are several factors to take into consideration when choosing a sampling device. Care should be taken when reviewing the advantages or disadvantages of any one device. It may be appropriate to use a different device to sample than that which was used to purge. The most common example of this is the use of a submersible pump to purge and a bailer to sample.

7.4.1 Bailers

The positive-displacement volatile sampling bailer is perhaps the most appropriate for collection of water samples for volatile analysis. Other bailer types (messenger, bottom fill, etc.) are less desirable, but may be mandated by cost and site conditions.

7.4.1.1 Operation

1. Surround the monitor well with clean plastic sheeting. If using the GPI bailer, insert a vial into the claim and assemble the unit.
2. Attach a line to a clean decontaminated bailer.
3. Lower the bailer slowly and gently into the well, taking care not to shake the casing sides or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.
4. Allow bailer to fill and then slowly and gently retrieve the bailer from the well avoiding contact with the casing, so as not to knock flakes of rust or other foreign materials into the bailer. If using the GPI bailer for collecting volatile organic samples, once at the surface remove the bailer from the cable. Carefully open the GPI bailer unit and remove the vial. Begin slowly pouring from the bailer, and collect the duplicate samples from the midstream sample.
5. Remove the cap from the sample container and place it on the plastic sheet or in a location where it won't become contaminated. See Section 7.7 for special considerations on VOA samples.
6. Begin slowly pouring from the bailer.
7. Filter and preserve samples as required by sampling plan.
8. Cap the sample container tightly and place prelabeled sample container in a carrier.
9. Replace the well cap.

10. Log all samples in the site logbook and on field data sheets and label all samples.
11. Package samples and complete necessary paperwork.
12. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

7.4.2 Submersible Pumps

Although it is recommended that samples not be collected with a submersible pump due to the reasons stated in Section 4.4.2, there are some situations where they may be used.

7.4.2.1 Operation

1. Allow the monitor well to recharge after purging, keeping the pump just above screened section.
2. Attach gate valve to hose (if not already fitted), and reduce flow of water to a manageable sampling rate.
3. Assemble the appropriate bottles.
4. If no gate valve is available, run the water down the side of a clean jar and fill the sample bottles from the jar.
5. Cap the sample container tightly and place prelabeled sample container in a carrier.
6. Replace the well cap.
7. Log all samples in the site logbook and on the field data sheets and label all samples.
8. Package samples and complete necessary paperwork.
9. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.

10. Nonfiltered samples shall be collected directly from the outlet tubing into the sample bottle.

11. For filtered samples, connect the pump outlet tubing directly to the filter unit. The pump pressure should remain decrease so that the pressure build up on the filter does not blow out the pump bladder or displace the filter. For the Geotech barrel filter, no actual connections are necessary so this is no a concern.

7.4.3 Non-Contact Gas Bladder Pumps

The use of a non-contact gas positive displacement bladder pump is often mandated by the use of dedicated pumps installed in wells. These pumps are also suitable for shallow (less than 100 feet) wells. They are somewhat difficult to clean, but may be used with dedicated sample tubing to avoid cleaning. These pumps require a power supply and a compressed gas supply (or compressor). They may be operated at variable flow and pressure rates making them ideal for both purging and sampling.

Barcelona (1984) and Nielsen (1985) report that the non-contact gas positive displacement pumps cause the least amount of alteration in sample integrity as compared to other sample retrieval methods.

7.4.3.1 Operation

1. Allow well to recharge after purging.
2. Assemble the appropriate bottles.
3. Turn pump on, increase the cycle time and reduce the pressure to the minimum that will allow the sample to come to the surface.
4. Cap the sample container tightly and place prelabeled sample container in a carrier.
5. Replace the well cap.
6. Package samples and complete necessary
7. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

8. On completion, remove the tubing from the well and either replace the Teflon tubing and bladder with new dedicated tubing and bladder or rigorously decontaminate the existing materials.
9. Nonfiltered samples shall be collected directly from the outlet tubing into the sample bottle.
10. For filtered samples, connect the pump outlet tubing directly to the filter unit. The pump pressure should remain decreased so that the pressure build up on the filter does not blow out the pump bladder or displace the filter. For the Geotech barrel filter, no actual connections are necessary so this is not a concern.

7.4.4 Suction Pumps

In view of the limitations of these type pumps, they are not recommended for sampling procedures.

7.4.5 Inertia Pumps

Inertia pumps may be used to collect samples. It is more common, however, to purge with these pumps and sample with a bailer (Section 7.4.1).

7.4.5.1 Operation

1. Following well evacuation, allow the well to recharge.
2. Assemble the appropriate bottles.
3. Since these pumps are manually by the sampler. The sample may be discharged from the pump outlet directly into the appropriate sample container.
4. Cap the sample container tightly and place prelabeled sample container in a carrier.
5. Replace the well cap.
6. Log all samples in the site logbook and on field data sheets and label all samples.

7. Package samples and complete necessary paperwork.
8. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.
9. Upon completion, remove pump and decontaminate or discard, as appropriate.

7.4.6. Sample Retrieval - Syringe

A limited number of commercial syringe type samplers are available, (IEA, TIMCO, etc.) some are homemade devices. These devices are claimed to provide good quality samples for volatile analysis, but are severely limited in sample volume and are specific to sampling for volatiles. Essentially, they operated with an evacuated chamber that is lowered down the well, and allowed to fill with the pressure of the water. The entire mechanism is then brought to the surface with the sample. The sample may then be transferred to a sample vial, or the entire unit may be sent as the sample container.

1. Evacuate the syringe if necessary, and lower the sampling device to just below the well screen.
2. Remove the constriction from the device and allow the sample to fill the syringe, apply slight suction as necessary.
3. Bring unit to the surface. If necessary, transfer the sample to vials, as outlined in steps 2 through 7 above.

7.5 Filtering

For samples requiring filtering, such as total metals analysis, the filter must be decontaminated prior to and between uses. Filters work by two methods. A barrel filter such as the "Geotech" filter works with a bicycle pump, used to build up positive pressure in the chamber containing the sample which is then forced through the filter paper (minimum size 0.45 μm) into a jar placed underneath. The barrel itself is filled manually from the bailer or directly via the

hose of the sampling pump. The pressure must be maintained up to 30 lbs/in by periodic pumping.

A vacuum type filter involves two chambers; the upper chamber contains the sample and a filter (minimum size 0.45 μm) divides the chambers. Using a hand pump or a Gilian type pump, air is withdrawn from the lower chamber, creating a vacuum and thus causing the sample to move through the filter into the lower chamber where it is drained into a sample jar. Repeated pumping may be required to drain all the sample into the lower chamber. If preservation of the sample is necessary, this should be done after filtering.

7.6 Post Operation

After all samples are collected and preserved, the sampling equipment should be decontaminated prior to sampling another well to prevent cross-contamination of equipment and monitor wells between locations.

1. Decontaminate all equipment.
2. Replace sampling equipment in storage containers.
3. Prepare and transport ground water samples to the laboratory. Check sample documentation and make sure samples are properly packed for shipment.

7.7 Special Considerations for VOA Sampling

The proper collection of a sample for volatile organics requires minimal disturbance of the sample to limit volatilization and therefore a loss of volatiles from the sample.

Sample retrieval systems suitable for the valid where: collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must be to provide a valid sample for analysis, one which

has been subjected to the least amount of turbulence possible.

The following procedures should be followed:

1. Open the vial, set cap in a clean place, and collect the sample during the middle of the cycle. When collecting duplicates, collect both samples at the same time.
2. Fill the vial to just overflowing. Do not rinse the vial, nor excessively overflow it. There should be a convex meniscus on the top of the vial.
3. Check that the cap has not been contaminated (splashed) and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not over tighten and break the cap.
4. Invert the vial and tap gently. Observe vial for at least ten (10) seconds. If an air bubble appears, discard the sample and begin again. It is imperative that no entrapped air is in the sample vial.
5. Immediately place the vial in the protective foam sleeve and place into the cooler, oriented so that it is lying on its side, not straight up.
6. The holding time for VOAs is seven days. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time. Ensure that the samples remain at 4 C, but do not allow them to freeze.

8.0 Calculations If it is necessary to calculate the volume of the well, utilize the following equation:

$$\text{Well volume} = \pi r^2 h \text{ (cf)}$$

- π = pi
 r = radius of monitoring well (feet)
 h = height of the water column (feet)
[This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]

cf = conversion factor (gal/ft³) = 7.48 3
gal/ft³ [In this equation, 7.48 gal/ft³
is the necessary conversion factor.]

9.0 Quality Assurance/Quality Control

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.
3. The collection of rinsate blanks is recommended to evaluate potential for cross contamination from the purging and/or sampling equipment.
4. Trip blanks are required if analytical parameters include VOAs.

10.0 Data Validation

This section is not applicable to this SOP.

11.0 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA or corporate health and safety guidelines. More specifically, depending upon the site specific contaminants, various protective programs must be implemented prior to sampling the first well. The site health and safety plan should be reviewed with specific emphasis placed on the protection program planned for the well sampling tasks. Standard safe operating practices should be followed such as minimizing contact with potential contaminants in both the vapor phase and liquid matrix through the use of respirators and disposable clothing.

When working around volatile organic contaminants:

1. Avoid breathing constituents venting from the well.
2. Pre-survey the well head-space with an FID/PID prior to sampling.
3. If monitoring results indicate organic constituents, sampling activities may be conducted in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing.

Physical hazards associated with well sampling:

1. Lifting injuries associated with pump and bailers retrieval; moving equipment.
2. Use of pocket knives for cutting discharge hose.
3. Heat/cold stress as a result of exposure to extreme temperatures and protective clothing.
4. Slip, trip, fall conditions as a result of pump discharge.
5. Restricted mobility due to the wearing of protective clothing.
6. Electrical shock associated with use of submersible pumps is possible. Use a GFCI or a copper grounding stake to avoid this problem.

12.0 References

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Disposal Sample Collection (from Drums) Page 1

SOP # FW-C-010

REVISION DATE: November 18, 1998

1.0 Scope and Application

The purpose of this standard operating procedure (SOP) is to provide technical guidance on implementing safe and cost-effective response actions at hazardous waste sites containing drums with unknown contents. Container contents are sampled and characterized for disposal, bulking, recycling, segregation, and classification purposes.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) or Carlson Environmental, Inc. (CEI) endorsement or recommendation for use.

2.0 Method Summary

Prior to sampling, drums must be excavated, (if necessary), inspected, staged, and opened. Drum excavation must be performed by qualified personnel. Inspection involves the observation and recording of visual qualities of each drum and any characteristics pertinent to the classification of the drum's contents.

Staging involves the physical grouping of drums according to classifications established during the physical inspection.

Opening of closed drums can be performed manually or remotely. Remote drum opening is recommended for worker safety. The most widely used method of sampling a drum involves the use of a glass thief. This method is quick, simple, relatively inexpensive, and requires no decontamination. The contents of a drum can be further characterized by performing various field tests.

3.0 Sample Preservation, Containers, Handling and Storage

Samples collected from drums are considered waste samples and as such, adding preservatives is not required due to the potential reaction of the sample with the preservative. Samples should, however, be cooled to 4 C and protected from sunlight in order to minimize any potential reaction due to the light sensitivity of the sample.

Sample bottles for collection of waste liquids, sludges, or solids are typically wide mouth amber jars with Teflon-lined screw caps. Actual volume required for analysis should be determined in conjunction with the laboratory performing the analysis.

Waste sample handling procedures should be as follows:

1. Label the sample container with the appropriate sample label and complete the appropriate field data sheet(s). Place sample container into two resealable plastic bags.
2. Place each bagged sample container into a shipping container which has been lined with plastic. Pack the container with enough non-combustible, absorbent, cushioning material to minimize the possibility of containers breaking, and to absorb any material which may leak.

Note: Depending on the nature and quantity of the material to be shipped, different packaging may be required. The transportation company or a shipping/receiving expert should be consulted prior to packing the samples.

3. Complete a chain of custody record for each shipping container, place into a resealable plastic bag, and affix to the inside lid of the shipping container.
4. Secure and custody seal the lid of the shipping container. Label the shipping container appropriately and arrange for the appropriate

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Disposal Sample Collection (from Drums) Page 2

transportation mode consistent with the type of hazardous waste involved.

4.0 Interferences and Potential Problems

If buried drums are suspected, geophysical investigation techniques such as magnetometry or ground penetrating radar may be employed in an attempt to determine the location and depth of drums. During excavation, the soil must be removed with great caution to minimize the potential for drum rupture.

Until the contents are characterized, sampling personnel should assume that unlabeled drums contain hazardous materials. Labeled drums are frequently mislabelled, especially drums that are reused. Because a drum's label may not accurately describe its contents, extreme caution must be exercised when working with or around drums.

If a drum which contains a liquid cannot be moved without rupture, its contents may be immediately transferred to a sound drum using an appropriate method of transfer based on the type of waste. In any case, preparations should be made to contain the spill (i.e., spill pads, dike, etc.) should one occur.

If a drum is leaking, open, or deteriorated, then it must be placed immediately in overpack containers.

The practice of tapping drums to determine their contents is neither safe nor effective and should not be used if the drums are visually over pressurized or if shock-sensitive materials are suspected. A laser thermometer may be effective in order to determine the level of the drum contents via surface temperature differences.

Drums that have been over pressurized to the extent that the head is swollen several inches above the level of the chime should not be moved. A number of devices have been developed for venting critically swollen drums. One method that has proven to be effective is a tube and spear device. A light aluminum tube is positioned at the vapor space of the drum. A rigid, hooking device attached to the tube, goes over the chime and holds the tube

securely in place. The spear is inserted in the tube and positioned against the drum wall. A sharp blow on the end of the spear drives the sharpened tip through the drum and the gas vents along the grooves. Venting should be done from behind a wall or barricade. Once the pressure has been relieved, the bung can be removed and the drum sampled.

Because there is potential for accidents to occur during handling, particularly initial handling, drums should only be handled if necessary. All personnel should be warned of the hazards prior to handling drums. Overpack drums and an adequate volume of absorbent material should be kept near areas where minor spills may occur. Where major spills may occur, a containment berm adequate to contain the entire volume of liquid in the drums should be constructed before any handling takes place. If drum contents spill, personnel trained in spill response should be used to isolate and contain the spill.

5.0 Equipment/Apparatus

The following are standard materials and equipment required for sampling:

- Personal protection equipment
- Wide-mouth amber glass jars with Teflon cap liner, approximately 500 mL volume
- Other appropriate sample jars
- numbered sample identification labels with corresponding data sheets
- Drum/Tank Sampling Data Sheets and Field Test Data Sheets for Drum/Tank Sampling
- Chain of Custody records
- Decontamination materials
- Glass thieving tubes or COLIWASA
- Coring device
- Stainless steel spatula or spoons
- Laser thermometer
- Drum overpacks
- Absorbent material for spills
- Drum opening devices

Bung Wrench

A common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of a non-sparking metal alloy (i.e., brass, bronze/manganese, aluminum, etc.) formulated to reduce the likelihood of sparks. The use of a "NON-SPARKING" wrench does not completely eliminate the possibility spark being produced.

Drum Deheader

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums. Drums with removable heads must be opened by other means.

Hand Pick, Pickaxe, and Hand Spike

These tools are usually constructed of brass or a non-sparking alloy with a sharpened point that can penetrate the drum lid or head when the tool is swung. The hand picks or pickaxes that are most commonly used are commercially available; whereas, the spikes are generally uniquely fabricated four foot long poles with a pointed end.

Backhoe Spike

Another means used to open drums remotely for sampling is a metal spike attached or welded to a backhoe bucket. This method is very efficient and is often used in large-scale operations.

Hydraulic Drum Opener

Recently, remotely operated hydraulic devices have been fabricated to open drums. This device uses hydraulic pressure to force a non-sparking spike through the wall of a drum. It consists of a manually

operated pump which pressurizes fluid through a length of hydraulic line.

Pneumatic Devices

A pneumatic bung remover consists of a compressed air supply that is controlled by a two-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill, which is adapted to turn bung fitting selected to fit the bung to be removed. An adjustable bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

6.0 Reagents

Reagents are not typically required for preserving drum samples. However, reagents will be utilized for decontamination of sampling equipment.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or preclean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Drum Excavation

If it is presumed that buried drums are on-site and prior to beginning excavation activities, geophysical investigation techniques should be utilized to approximate the location and depth of the drums. In addition, it is important to ensure that all locations where excavation will occur are clear of utility lines, pipes and poles (subsurface as well as above surface).

Excavating, removing, and handling drums are generally accomplished with conventional heavy construction equipment. These activities should be performed by an equipment operator who has experience in drum excavation. During excavation activities, drums must be approached in a manner that will avoid digging directly into them.

The soil around the drum should be excavated with non-sparking hand tools or other appropriate means and as the drums are exposed, a visual inspection should be made to determine the condition of the drums. Ambient air monitoring should be done to determine the presence of unsafe levels of volatile organics, explosives, or radioactive materials. Based on this preliminary visual inspection, the appropriate mode of drum excavation and handling may be determined.

Drum identification and inventory should begin before excavation. Information such as location, date of removal, drum identification number, overpack status, and any other identification marks should be recorded on the Drum/Tank Sampling Data Sheet

7.3 Drum Inspection

Appropriate procedures for handling drums depend on the contents. Thus, prior to any handling, drums should be visually inspected to gain as much

information as possible about their contents. The drums should be inspected for the following:

1. Drum condition, corrosion, rust, punctures, bungs, and leaking contents.
2. Symbols, words, or other markings on the drum indicating hazards (i.e., explosive, radioactive, toxic, flammable), or further identifying the drums.
3. Signs that the drum is under pressure.
4. Shock sensitivity.

Monitoring should be conducted around the drums using instruments such as radiation meters, organic vapor analyzers (OVA) and combustible gas indicators (CGI).

Survey results can be used to classify the drums into categories, for instance:

- Radioactive
- Leaking/deteriorating
- Bulging
- Lab packs
- Explosive/shock sensitive
- Empty

All personnel should assume that unmarked drums contain hazardous materials until their contents have been categorized. Once a drum has been visually inspected and any immediate hazard has been eliminated by overpacking or transferring the drum's contents, the drum is affixed with a numbered tag and transferred to a staging area. Color-coded tags, labels or bands should be used to identify the drum's category based on visual inspection. A description of each drum, its condition, any unusual markings, the location where it was buried or stored, and field monitoring information are recorded on a Drum/Tank Sampling Data Sheet. This data sheet becomes the principal record keeping tool for tracking the drum on-site.

7.4 Drum Staging

Prior to sampling, the drums should be staged to allow easy access. Ideally, the staging area should be located just far enough from the drum opening area to prevent a chain reaction if one drum should explode or catch fire when opened.

During staging, the drums should be physically separated into the following categories: those containing liquids, those containing solids, those containing lab packs, and those which are empty. This is done because the strategy for sampling and handling drums/containers in each of these categories will be different. This may be achieved by visual inspection of the drum and its labels, codes, etc. Solids and sludges are typically disposed of in open top drums. Closed head drums with a bung opening generally contain liquid.

Where there is good reason to suspect that drums contain radioactive, explosive, or shock-sensitive materials, these drums should be staged in a separate, isolated area. Placement of explosives and shock-sensitive materials in diked and fenced areas will minimize the hazard and the adverse effects of any premature detonation of explosives.

Where space allows, the drum opening area should be physically separated from the drum removal and drum staging operations. Drums are moved from the staging area to the drum opening area one at a time using forklift trucks equipped with drum grabbers or a barrel grapple. In a large-scale drum handling operation, drums may be conveyed to the drum opening area using a roller conveyor. Drums may be restaged as necessary after opening and sampling.

7.5 Drum Opening

There are three basic techniques available for opening drums at hazardous waste sites:

- Manual opening with non-sparking bung wrenches
- Drum deheading
- Remote drum puncturing or bung removal

The choice of drum opening techniques and accessories depends on the number of drums to be opened, their waste contents, and physical condition. Remote drum opening equipment should always be considered in order to protect worker safety. Under OSHA 1910.120, manual drum opening with bung wrenches or deheaders should be performed ONLY with structurally sound drums and waste contents that are known to be non-shock sensitive, non-reactive, non-explosive, and non-flammable.

7.5.1 Manual Drum Opening with a Bung Wrench

Manual drum opening with bung wrenches should not be performed unless the drums are structurally sound (no evidence of bulging or deformation) and their contents are known to be non-shock sensitive, non-reactive, non-explosive or non-flammable. If opening the drum with bung wrenches is deemed safe, then certain procedures should be implemented to minimize the hazard:

- Field personnel should be fully outfitted with protective gear.
- Drums should be positioned upright with the bung up, or, for drums with bungs on the side, laid on their sides with the bung plugs up.
- The wrenching motion should be a slow, steady pull across the drum. If the length of the bung wrench handle provides inadequate leverage for unscrewing the plug, a "cheater bar" can be attached to the handle to improve leverage.

7.5.2 Manual Drum Opening with a Drum Deheader

Drums are opened with a drum deheader by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the

CEI STANDARD OPERATING PROCEDURES

Disposal Sample Collection (from Drums) Page 6

initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote method prior to using the deheader.

Self-propelled drum openers which are either electrically or pneumatically driven are available and can be used for quicker and more efficient deheading.

The drum deheader should be decontaminated, as necessary, after each drum is opened to avoid cross contamination and/or adverse chemical reactions from incompatible materials.

7.5.3 Manual Drum Opening with a Hand Pick, Pickaxe, or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, then it can be opened for sampling by using a hand pick, pickaxe, or spike. Often the drum lid or head must be hit with a great deal of force in order to penetrate it. Because of this, the potential for splash or spraying is greater than with other opening methods and therefore, this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums, some of which may be under pressure, cannot be opened slowly with these tools, spray from drums is common and appropriate safety measures must be taken. The pick or spike should be decontaminated after each drum is opened to avoid cross contamination and/or adverse chemical reaction from incompatible materials.

7.5.4 Remote Drum Opening with a Backhoe Spike

Remotely operated drum opening tools are the safest available means of drum opening. Remote drum opening is slow, but provides a high degree of safety compared to manual methods of opening.

In the opening area, drums should be placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike should be decontaminated after each drum is opened to prevent cross contamination and/or adverse reaction from incompatible material. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This combined with the normal personal protection gear should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board airline system.

7.5.5 Remote Drum Opening with Hydraulic Devices

A piercing device with a non-sparking, metal point is attached to the end of a hydraulic line and is pushed into the drum by the hydraulic pressure. The piercing device can be attached so that a hole for sampling can be made in either the side or the head of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place if desired and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

7.5.6 Remote Drum Opening with Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely. Prior to opening the drum, a bung fitting must be selected to fit the bung to be removed. The adjustable bracketing system is then attached to the drum and the pneumatic drill is aligned over the bung. This must be done before the drill can be operated. The operator then moves away from the drum to operate the equipment. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This remote bung opener does not permit the slow venting of the container, and therefore appropriate

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precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

7.6 Drum Sampling

After the drum has been opened, preliminary monitoring of headspace gases should be performed first with an explosimeter/oxygen meter. Afterwards, an OVA or other instruments should be used. If possible, these instruments should be intrinsically safe. In most cases it is impossible to observe the contents of these sealed or partially sealed drums. Since some layering or stratification is likely in any solution left undisturbed, a sample that represents the entire depth of the drum must be taken.

When sampling a previously sealed drum, a check should be made for the presence of a bottom sludge. This is easily accomplished by measuring the depth to apparent bottom then comparing it to the known interior depth.⁷

7.6.1 Glass Thief Sampler

The most widely used implement for sampling drum liquids is a glass tube commonly referred to as a glass thief. This tool is cost effective, quick, and disposable. Glass thieves are typically 6mm to 16mm I.D. and 48 inches long.

Procedures for Use:

1. Remove the cover from the sample container.
2. Insert glass tubing almost to the bottom of the drum or until a solid layer is encountered. About one foot of tubing should extend above the drum.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the sampling tube with a tapered stopper or thumb, ensuring liquid does not come into contact with stopper.

5. Carefully remove the capped tube from the drum and insert the uncapped end into the appropriate sample container.
6. Release stopper and allow the glass thief to drain until the container is approximately two-thirds full.
7. Remove tube from the sample container, break it into pieces and place the pieces in the drum.
8. Cap the sample container tightly and label it. Place the sample container into a carrier.
9. Replace the bung or place plastic over drum.
10. Log all samples in the site logbook and on Drum/Tank Sampling Data Sheets.
11. Perform hazard categorization analyses if included in the project scope.
12. Transport the sample to the decontamination zone and package it for transport to the analytical laboratory, as necessary. Complete chain of custody records.

In many instances a drum containing waste material will have a sludge layer on the bottom. Slow insertion of the sample tube into this layer; then a gradual withdrawal will allow the sludge to act as a bottom plug to maintain the fluid in the tube. The plug can be gently removed and placed into the sample container by the use of a stainless steel lab spoon.

It should be noted that in some instances disposal of the tube by breaking it into the drum may interfere with eventual plans for the removal of its contents. The use of this technique should be cleared with the project officer or other glass thief disposal techniques should be evaluated.

7.6.2 COLIWASA Sampler

The Composite Liquid Waste Sampler (COLIWASA) and modifications thereof are equipment that collect a sample from the full depth

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Disposal Sample Collection (from Drums) Page 8

of a drum and maintain it in the transfer tube until delivery to the sample bottle. The COLIWASA is a much cited sampler designed to permit representative sampling of multi phase wastes from drums and other containerized wastes. One configuration consists of a 152 cm by 4 cm I.D. section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end.

Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper.

The major drawbacks associated with using a COLIWASA concern decontamination and costs. The sampler is difficult to decontaminate in the field and its high cost in relation to alternative procedures (glass tubes) make it an impractical throwaway item. It still has applications, however, especially in instances when a true representation of a multi phase waste is absolutely necessary.

Procedures for Use:

1. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.
2. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.
3. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.
4. Slowly withdraw the sample from the waste container with one hand while wiping the

sampler tube with a disposable cloth or rag with the other hand.

5. Carefully discharge the sample into the appropriate sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.
6. Cap the sample container tightly and label it. Place the sample container in a carrier.
7. Replace the bung or place plastic over the drum.
8. Log all samples in the site logbook and on Drum/Tank Sampling Data Sheets.
9. Perform hazard Categorization analyses if included in the project scope.
10. Transport the sample to the decontamination zone and package for transport to the analytical laboratory, as necessary. Complete the Chain of Custody records.

7.6.3 Coring Device

A coring device may be used to sample drum solids. Samples should be taken from different areas within the drum. This sampler consists of a series of extensions, a T-handle, and the coring device.

1. Assemble the sampling equipment.
2. Remove the cover from the sample container.
3. Insert the sampling device to the bottom of the drum. The extensions and the "T" handle should extend above the drum.
4. Rotate the sampling device to cut a core of material.
5. Slowly withdraw the sampling device so that as much sample material as possible is retained within it.

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Disposal Sample Collection (from Drums) Page 9

6. Transfer the sample to the appropriate sample container, and label it. A stainless steel spoon or scoop may be used as necessary.
7. Cap the sample container tightly and place it in a carrier.
8. Replace the bung or place plastic over the drum.
9. *Log all samples in the site log book and on Drum/Tank Sampling Data Sheets.*
10. Perform hazard categorization analyses if included in the project scope.
11. Transport the sample to the decontamination zone and package it for transport to the analytical laboratory, as necessary. Complete chain of custody records.

7.7 Hazard Categorization

The goal of characterizing or categorizing the contents of drums is to obtain a quick, preliminary assessment of the types and levels of pollutants contained in the drums. These activities generally involve rapid, non-rigorous methods of analysis. The data obtained from these methods can be used to make decisions regarding drum staging or restaging, bulking or compositing of the drum contents.

As a first step in obtaining these data, standard tests should be used to classify the drum contents into general categories such as auto-reactives, water reactives, inorganic acids, organic acids, heavy metals, pesticides, cyanides, inorganic oxidizers, and organic oxidizers. In some cases, further analyses should be conducted to more precisely identify the drum contents.

There are several methods available to perform these tests:

- the HazCat chemical identification system
- the Chlor-N-Oil Test Kit
- Spill-fyter Chemical Classifier Strips
- Setaflash(for ignitability)

These methods must be performed according to the manufacturers' instructions and the results must be documented on the Field Test Data Sheet for Drum/Tank Sampling.

Other tests which may be performed include:

- Water Reactivity
- Specific Gravity Test (compared to water)
- Water Solubility Test
- pH of Aqueous Solution

The tests must be performed in accordance with the instructions on the Field Test Data Sheet for Drum/Tank Sampling and results of the tests must be documented on these data sheets.

The specific methods that will be used for hazard categorization must be documented in the Quality Assurance Work Plan.

8.0 Calculations

This section is not applicable to this SOP.

9.0 Quality Assurance/Quality Control

The following general quality assurance procedures apply:

1. All data must be documented on Chain of Custody records, Drum/Tank Sampling Data Sheets, Field Test Data Sheet for Drum/Tank Sampling, or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 Data Validation

This section is not applicable to this SOP.

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Disposal Sample Collection (from Drums) Page 10

11.0 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures.

More specifically, the opening of closed containers is one of the most hazardous site activities. Maximum efforts should be made to ensure the safety of the sampling team. Proper protective equipment and a general awareness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended.

12.0 References -U.S. EPA Environmental Response Team, SOP #2009 Rev. 0-0, October 3 1994.

Guidance Document for Cleanup of Surface Tank and Drum Sites, OSWER Directive 9380.0-3.

Drum Handling Practices at Hazardous Waste Sites, EPA-600/2-86-013.10

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CEI STANDARD OPERATING PROCEDURES

Completing Soil Boring Logs

Page 1

SOP # FW-R-001

REVISION DATE: August 24, 1998

1.0 Scope and Application - This SOP is intended to provide guidance for complete soil boring logs during the field activities.

2.0 Method Summary - A soil boring log shall be completed during the emplacement and sampling of each soil boring. The boring log is intended to provide a record of the sampling activities, a description of the geological material encountered, and record any field observations such as visual evidence of contamination, odors, field obstructions, etc.

The hand-written boring log will be transformed into a document using proprietary software. The document can then be printed and included in the report detailing the project field activities

3.0 Sample Preservation, Containers, Handling and Storage - *Not applicable.*

4.0 Interferences and Potential Problems - *Not applicable.*

Care should be taken to ensure that the correct boring number, sample numbers, sampling date and times are properly recorded. Upon completion of each boring, the boring log should be reviewed to confirm it has been filled out completely.

5.0 Equipment/Apparatus - A copy of a boring log is attached for reference. In general, the forms should be completed in ink. However, if it is raining, a pencil can be used.

The drilling contractor will provide the necessary equipment for advancing the boring. CEI equipment includes:

- Blank boring logs
- clipboard
- writing utensil
- gloves, and applicable PPE
- compass
- ruler
- sample containers
- ice/coolers

- chain-of-custody forms
- packaging materials

6.0 Reagents - *Not applicable.*

7.0 Procedure - The general steps for completing the boring log are outlined below.

1. Write the project name, project number and boring number on the log.
2. Complete the information box with the applicable information (i.e., date, time, logged by, etc.)
3. The depth interval should be filled out to indicate what sample intervals were used during the sampling process (typically 2-foot intervals).
4. The unique sample identification number should be filled out for each sample interval. This number should correspond to the sample numbers listed on the sample containers and on the chain-of-custody forms.
5. The time each sample is retrieved from the borehole should be noted on the log.
6. Once the sampling sleeve or split-spoon sampler is opened, the recovery should be recorded on the log.
7. Any additional field measurements such as PID or OVA readings, or blow counts (when applicable) should be recorded on the logs.
8. The material description should be written in the appropriate column and should include a general description of the USCS soil type, color, moisture content, and any other relevant descriptors.
9. Remarks including visual or olfactory evidence of contamination, or field obstructions should be recorded in the remarks column.

CEI STANDARD OPERATING PROCEDURES

Completing Soil Boring Logs

Page 2

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10. If ground water is encountered, it should be noted in the materials description section.
 11. At the completion of the boring, the final boring depth should be noted on the log.
 12. The original field logs should be maintained in the project files.
 13. Copies of the logs should be made for entry into the proprietary software program so the logs can be printed and included in the written report detailing the field activities.

8.0 Calculations - *Not applicable.*

9.0 Quality Assurance/Quality Control - *Not applicable.*

10.0 Data Validation - *Not applicable.*

11.0 Health and Safety - CEI personnel should follow the corporate health and safety guidelines and the site-specific health and safety plan for the project.

12.0 References - *Not applicable.*

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CARLSON ENVIRONMENTAL, INC.
65 East Wacker Place
Chicago, Illinois 60601
312/346-2140

Log of Boring SB-

(Page 1 of 1)

Fansteel
North Chicago, IL

PN:9566B

Date & Time Started :
Date & Time Finished :
Logged By :
Depth to water :

Surface Elevation : NA
Driller :
Drill Method : Geoprobe
Sample Method :

Depth in feet	Sample Number	Depth Interval	Time	Recov. (inches)	PID (units)	Depth in feet	Graphic Log	USCS Log	Materials Description	Remarks
0						0				
SB- A	0-2									
2						2				
SB- B	2-4									
4						4				
SB- C	4-6									
6						6				
SB- D	6-8									
8						8				
SB- E	8-10									
10						10				
SB- F	10-12									
12						12				
SB- G	12-14									
14						14				
SB- H	14-16									
16						16				
SB- I	16-18									
18						18				
SB- J	18-20									
20						20				
22						22				

CEI STANDARD OPERATING PROCEDURES

Completing Well Installation Logs

Page 1

SOP # FW-R-002

REVISION DATE: August 25, 1998

1.0 Scope and Application - This SOP is intended to provide guidance for complete ground water monitoring well logs during the installation activities.

2.0 Method Summary - A ground water monitoring well log shall be completed during the construction of each ground water monitoring well. The well log is intended to provide a record describing the well construction activities.

The hand-written well log will be transformed into a document using proprietary software. The document can then be printed and included in the report detailing the project field activities

3.0 Sample Preservation, Containers, Handling and Storage - *Not applicable.*

4.0 Interferences and Potential Problems - *Not applicable.*

Care should be taken to ensure that the correct measurements, well numbers, sampling date and times are properly recorded. Upon completing the installation of each well, the corresponding well log should be reviewed to confirm it has been filled out completely.

5.0 Equipment/Apparatus - A copy of a well log is attached for reference. In general, the forms should be completed in ink. However, if it is raining, a pencil can be used.

The drilling contractor will provide the necessary equipment for installing the well. CEI equipment includes:

- Blank well logs
- clipboard
- writing utensil

6.0 Reagents - *Not applicable.*

7.0 Procedure - The general steps for completing the boring log are outlined below.

1. Write the project name, project number and boring number on the log.
2. Complete the information box with the applicable information (i.e., date, contractor, etc.)
3. The depths and materials involved in the well construction should be noted.

Additional information regarding the development and sampling techniques, volume of water removed, etc. should be recorded in the field logbook for the project.

The hand-written log should be maintained in the project files. After the well has been installed, developed, sampled and surveyed, this information should be combined with the log information and entered into the computer via the proprietary software. The completed log form can then be printed and included in the report detailing the project field activities.

8.0 Calculations - *Not applicable.*

9.0 Quality Assurance/Quality Control - *Not applicable.*

10.0 Data Validation - *Not applicable.*

11.0 Health and Safety - CEI personnel should follow the corporate health and safety guidelines and the site-specific health and safety plan for the project.

12.0 References - *Not applicable.*

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CARLSON ENVIRONMENTAL, INC.
65 East Wacker Place
Chicago, Illinois 60601
312/346-2140

Log of Boring MW-

(Page 1 of 1)

Fansteel
North Chicago, IL

PN:9566B

Installation Date :
Drilling Method : Geoprobe
Drilling Contractor :
Sampling Method :

Surface Elevation : ---
Casing Elevation : ---
Casing Stickup : ---
Surveyed : No

Depth
in
Feet

Well Construction Information

0
WELL CONSTRUCTION
Date Compl. :
Hole Diameter : 1.75"
Drilling Fluid : none
Company Rep. : CEI
2
WELL CASING
Material : Stainless Steel
Diameter : 1 in.
4
WELL SCREEN
Material : Stainless Steel
Diameter : 1 in.
Opening : .010 slot
WELL MATERIALS
Sand Pack : #5 quartz
Annulus Seal : Bentonite Pellets
Grout : Cement
6
COUNTY/STATE : Lake County, IL
8

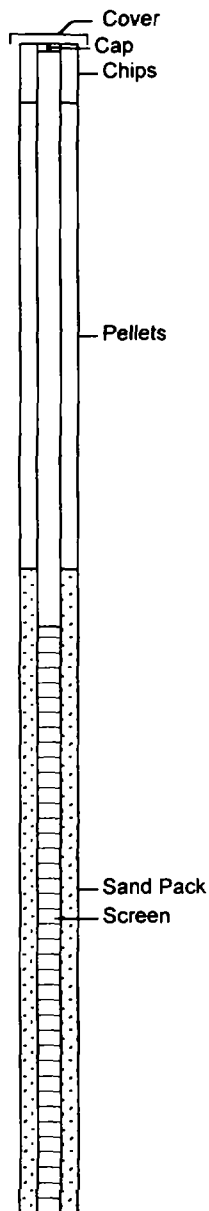
10
Development Technique(s)
and Dates:
Static Depth to Water Date:
Static Depth to Water(feet):
12
Ground Water Elevation:
Water Removed
During Development(gals):
14
Well Purpose: To collect ground water
sampling.

16
18
20
22

Graphic Log

Materials Description

Depth
in
Feet



CEI STANDARD OPERATING PROCEDURES

Chain-of-Custody Procedures

Page 1

SOP # FW-R-003

REVISION DATE: August 28, 1998

1.0 Scope and Application - This SOP is intended to outline the general process for completing chain-of-custody forms. Following the chain-of-custody process provides paper trail indicating who was in possession of samples over a period of time.

2.0 Method Summary - The chain-of-custody process provides a method of tracking sample possession. If chain-of-custody procedures improperly followed, the validity of the samples can be called into question, particularly in a court of law.

Once collected, all samples should be labeled and maintained at appropriate holding temperatures. A chain-of-custody form should be filled out by the sampler. If custody of the samples is transferred (i.e. to the laboratory), the chain-of-custody form should be signed and dated by the individual receiving custody of the samples.

3.0 Sample Preservation, Containers, Handling and Storage - *Not applicable.*

4.0 Interferences and Potential Problems - If the proper chain-of-custody procedures are not followed or fully documented, the validity of the samples is called into question. Care should be taken when filling out the chain-of-custody form to ensure it is fully and completely filled out, all dates are correct, and the form is signed by the appropriate sampler.

5.0 Equipment/Apparatus - A sample chain-of-custody form is attached for reference.

6.0 Reagents - *Not applicable.*

7.0 Procedure - Upon sample collection, all samples should be listed on a chain-of-custody. Samples that are not selected for submission to a laboratory for laboratory analysis should be listed on a separate chain-of-custody with "hold for possible analysis" written in the "remarks" area of the form.

All chain-of-custody forms should be completed in ink. Any "cross-outs" should be performed with a single stroke through the error and should be

initialed and dated by the individual making the correction. The general steps for filling out the chain-of-custody forms are as follows:

1. Fill in the Project Number and Project Name in the appropriate boxes.
2. The sampler should sign the signature box.
3. The sample number, date and time should be filled out and "comp" or "grab" should be checked to indicate if the sample was a composite or grab sample, respectively.
4. The sample description should be filled out to include a description of the sample matrix (i.e., soil or ground water). Additional description can be provided (i.e., sample depth, location, etc.).
5. The number of containers should be recorded. This number should reflect the total number of containers collected for that unique sample number.
6. The analysis should be written in the "analysis desired" area. A check mark should be placed in the column beneath each specified analysis to indicate which samples should be analyzed for that particular analysis. The analysis should be specific to avoid confusion and misunderstandings with the laboratory (i.e., "total RCRA metals" should be written instead of "metals").
7. Any remarks corresponding to a particular sample can be listed in the remarks column on the far left.
8. Any special communication to the laboratory should be written in the remarks box on the lower right portion of the form.
9. When the custody of the samples is transferred, the sampler that signed the form should also sign the form in the box that says "relinquished by". Whomever received the samples should

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Chain-of-Custody Procedures

Page 2

sign the corresponding "received by" box and fill in the date and time.

10. The sampler that relinquished custody should retain the bottom (pink) portion of the form. This form should be maintained with the project files. The remaining two copies of the form should accompany the samples.
11. Any subsequent transfer of the samples should continue to be documented on the chain-of-custody form.
12. Upon receipt of the samples at the accredited laboratory, the laboratory identification numbers should be added to the chain-of-custody form. A copy of the final chain-of-custody form should be returned to CEI as part of the laboratory analytical report.

8.0 Calculations - *Not applicable.*

9.0 Quality Assurance/Quality Control - Project Managers should review the chain-of-custody forms on a regular basis. CEI's QA Manager should occasionally "spot-check" chain-of-custody forms to ensure that the procedures outlined in this SOP are being followed.

10.0 Data Validation - *Not applicable.*

11.0 Health and Safety - *Not applicable.*

12.0 References - *Not applicable.*

file - P:\SOP\CEI_SOPS\RECORD\FW_R_003.WPD



CEI

CHAIN-OF-CUSTODY RECORD

No. 8509

CARLSON ENVIRONMENTAL, INC.

312 W. Randolph St.

Chicago, IL 60606

(312) 346-2140

PROJ. NO.		PROJECT NAME					NUMBER OF CONTAINERS	ANALYSIS DESIRED (INDICATE SEPARATE CONTAINERS)										REMARKS	
SAMPLERS: (Signature)																			
ITEM NO.	SAMPLE NUMBER	DATE	TIME	COMP	GRAB	SAMPLE DESCRIPTION (INCLUDE MATRIX AND POINT OF SAMPLE)													
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

Relinquished by (Signature)	Date/Time	Received by (Signature)	REMARKS
Relinquished by (Signature)	Date/Time	Received by (Signature)	
Relinquished by (Signature)	Date/Time	Received for Laboratory by (Signature)	